DUAL TRACE OSCILLOSCOPE OS3600

Instruction Manual

From Serial No. 5000

GOULD

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Introduction

Section 1

100MHz represents a major step forward in instrumentation technology for Gould Advance; and the OS3600 is planned to be the forerunner of a comprehensive range of oscillocopes in the highest reaches of technology.

This dedication to providing oscilloscopes with major user benefits, both for general purpose and more specific applications, automatically results from the resources and in-house requirements of the multi-national Gould Corporation.

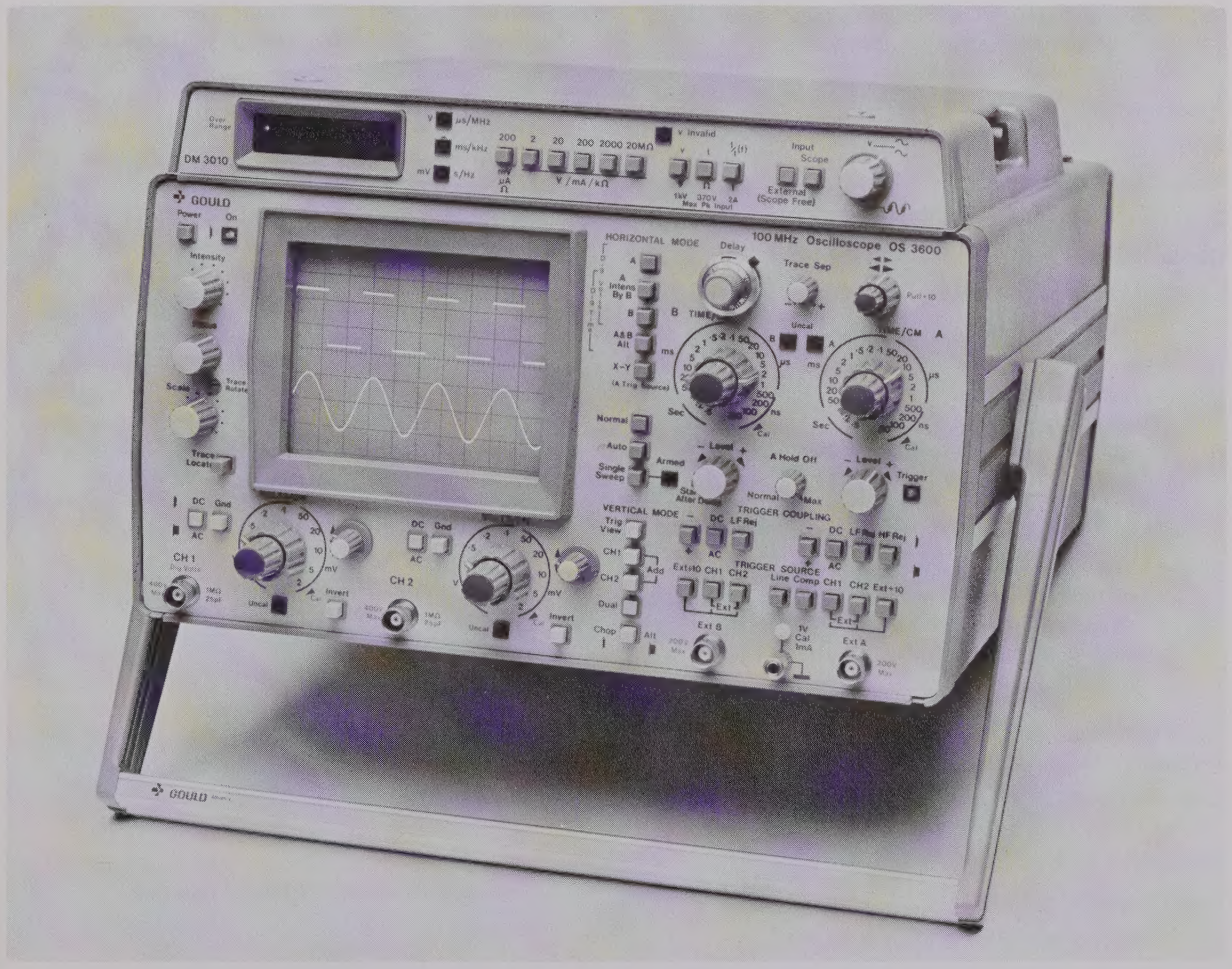
The OS3600 and its brother, the 60MHz OS3500 are eminently suitable for the measurement of digital circuits.

All are portable and ideal for field-service application. The wide range of amplifier and trigger bandwidths covered by these models allows a choice to be made which is appropriate to the logic family being measured.

Production requirements can be satisfied when using the oscilloscope with their rack-mount adaptors – the logical layout of the front panels making operation simple for the semi-skilled operator. The use of the optional digital measuring unit DM3010 increases reading accuracy and speeds-up measurement time.

The more varied and stringent requirements of the laboratory can also be met from the Gould range. For applications not covered by these powerful models, there is almost certainly another instrument in the range which will "do the job".

In brief, consider Gould if your application is development, production or servicing. For the future!



DISPLAY

CRT 8 x 10cm rectangular.

EHT 16kV overall.

Graticule Internal, with 8 x 10cm divisions and 2mm sub-divisions. Continuously variable illumination.

Phosphor P31 standard, P7 option.

Beam Finder Compresses trace to within graticule area regardless of settings of the vertical and horizontal position controls. Provides pre-set brilliance level.

VERTICAL DEFLECTION

Input Channels Two identical.

Bandwidth D.C.–100MHz (-3dB), d.c. coupled. 2Hz–100MHz (-3dB) a.c. coupled.

Rise Time < 3.5ns.

Input Coupling DC-Ground-AC.

Input Impedance 1MΩ/25pF.

Deflection Coefficient 2mV/cm to 5V/cm in 11 ranges (1-2-5 sequence) with uncalibrated fine gain control giving at least 2.5:1 reduction in gain. Warning light indicates uncalibrated condition.
N.B. Bandwidth at 2mV/cm limited to 85MHz.

Accuracy ±3%.

Position Control Shift range ± 8cm.

Signal Delay Allows triggered edge to be viewed.

Max. Input Voltage 400V (DC plus AC pk).

Display modes
CH1 only.
CH2 only
CH1 and CH2 chopped (500kHz approx.).
CH1 and CH2 alternate.
CH1 and CH2 added.
Trigger View, CH1 or CH2.
Trigger View, CH1 and CH2 alternate or chopped.
Trigger View, alternate or chopped with CH1 and CH2 added.
N.B. Channels 1 and 2 can be inverted.

Trigger View Enables the main timebase trigger signal to be continuously displayed. A trigger signal derived from an external source will have a deflection coefficient of approximately 50mV/cm (0.5V/cm with ÷ 10).

HORIZONTAL AMPLIFIER

Bandwidth D.C. – 2.0MHz (-3dB).

Deflection Coefficient 50mV/cm (500 mV/cm with ÷ 10).

Accuracy ± 15%.

Imput Impedance 1MΩ/25pF.

Max. Input Voltage 200V (D.C. + A.C. pk).

X-Y Operation With X input via External Trig. socket X specification as above. With X input via CH1 or CH2 sensitivity as attenuator setting but accuracy ± 15% (CH1) or ± 5% (CH2). Phase error < 3° at 500kHz.

HORIZONTAL DEFLECTION

Display Modes Main Timebase.
Main Timebase intensified by Delayed Timebase.
Delayed Timebase.
Main and Delayed Timebase simultaneously (alternate sweeps).
X-Y with CH1 or CH2 providing X-deflection input.
X-Y_1/Y_2 with line or ext. trig. socket providing X-deflection input.

	Main Timebase (A)	Delayed Timebase(B)
Sweep Speeds	50ns/cm to 0.5s/cm in 22 steps (1-2-5 sequence)	50ns/cm to 0.5s/cm in 22 steps (1-2-5 sequence)
Fine Sweep Control	Uncalibrated. Reduces sweep rate by at least 2.5 times. (longest sweep approx. 12.5s). Warning light indicates uncalibrated condition.	Uncalibrated. Reduces sweep rate by at least 2.5 times. (longest sweep approx. 12.5s). Warning light indicates uncalibrated condition.
Expansion	X10 gives max. sweep rate of 5ns/cm.	X10 gives max. sweep rate of 5ns/cm.
Accuracy	±3% (±5% with X10 expansion).	±3% (±5% with X10 expansion).
Sweep Delay	A10-turn calibrated vernier control operates with reference to the main timebase setting. Control of delayed timebase start variable from 0.2cm to 10.2cm. Differential Accuracy: ±1.5% rdg. ±0.1%f.s. Jitter: <1 in 10000 of full scale.	The delayed timebase can be started by the main timebase sweep or triggered after a preset sweep display.
Trace Separation	Operates in A and B timebase alternate sweep mode and provides approx. ±4.0cm shift on the B sweep.	

	Trigger (A)	Trigger (B)
Source	Internal CH1 Internal CH2 Composite (CH1/CH2) External External ÷ 10 Line	Internal CH1 Internal CH2 External External ÷ 10

Specification

Section 2

Slope	Pos/Neg.	Pos/Neg.
Coupling	DC DC(hf rej.), AC, AC (lf rej.), AC (hf rej.).	DC, AC, AC (lf rej.)
Modes	Manual level Auto (bright line) Single sweep	Manual level Trigger after delay
Sensitivity	Internal: To 10MHz<2mm (Below 50Hz sensitivity decreases when AC coupled) 10MHz-100MHz <1cm. 100MHz-150MHz 2cm typical	Internal: To 10MHz<2mm (Below 50Hz sensitivity decreases when AC coupled) 10MHz-100MHz <1cm. 100MHz-150MHz 2cm typical
	External: To 10MHz<10mV (100mV with ÷ 10) (Below 50Hz sensitivity decreases when AC coupled).	External: To 10MHz<10mV (100mV with÷ 10) (Below 50Hz sensitivity decreases when AC coupled).
	10MHz-100MHz < 50mV (<0.5V with ÷ 10). 100MHz-150MHz <100mV (< 2V with ÷ 10). Level range (internal): ±8cm. Level range (external): ±0.5V approx. (±5.0V with ÷ 10)	10MHz-100MHz< 50mV (<0.5V with ÷ 10). 100MHz-150MHz <100mV (< 2V with ÷ 10). Level range (internal): ±8cm. Level range (external): ±0.5V approx. (±5.0V with ÷ 10)
External Trigger	Input impedance, 1MΩ/25pF. Max. input volt 200V (DC plus AC pk).	Input impedance, 1MΩ/25pF. Max input volt 200V (DC plus AC pk).
Trigger Hold-off	Continuously variable up to approx. one sweep length of main timebase, except for three slowest ranges.	

CALIBRATOR

Voltage 1V ± 1%.

Frequency 1kHz approx.

Z MODULATION

Bandwidth DC to 10MHz.

Sensitivity +4V from zero gives complete blanking.

Input Impedance 2.2kΩ.

OUTPUTS

Main Timebase Ramp Output level zero to +4V from source impedance of 10kΩ.

Delayed Timebase Gate Output level +3v to zero from source impedance of 10kΩ.

SUPPLIES

Voltage 100V; 120V; 220V; 240V ± 10%.

Frequency 45–440Hz.

Consumption 80VA.

TEMPERATURE RANGE

Operating 0 to 50°C.

Operating within spec. +15°C to +35°C.

SIZE AND WEIGHT

Size 32.5cm x 18.0cm x 46.5cm (w x h x d) ex. handles and knobs.

Weight 10kg (22lb).

ACCESSORIES SUPPLIED

Handbook Pt. No. 450038

2 off 250MHz probe kits with x 10 attenuation PB14.

Lead supply Pt. No. 402001

OPTIONAL ACCESSORIES

Viewing Hood Pt. No. 42224.
Protective Cover (soft) Pt. No. 42225.
Front Panel Cover (hard) Pt. No. 42226.
Trolleys TR4 or TR6.
Rack Mount Kit Pt. No. 42227.

3.1 SWITCHING ON

CAUTION: The OS3600 is convection cooled and must always be operated in a position such that air circulating through the bottom and side vents is not restricted.

1. Set the support/carrying handle to the required operating position. The handle is released by pulling outward both fixing bushes when it can be turned to lock in any of 5 positions.
2. Before connecting the OS3600 to the supply, check that the supply range switches are set to suit the supply voltage to be used and that the correct fuse is fitted. Note that the fuse has to be changed when switching between the 100V and 220V ranges. The switches and fuse holder are mounted on the back panel of the instrument. Do not operate the range selection switches while the OS3600 is switched on.

SAFETY: The OS3600 is designed to be used with the the frame earthed and it is important that the appropriate lead (Green/Yellow) of the supply, PL98, is connected to a suitable earth.

3. Push the POWER button and ensure that the indicator lamp lights. A trace should be obtained within 1 minute and full calibrated performance within 15 minutes.

3.2 OBTAINING A TRACE

1. To obtain a trace:
   (a) Select CH1 on VERTICAL MODE switchbank.
   (b) Select A on HORIZONTAL MODE switchbank.
   (c) Select AUTO on NORMAL/AUTO/SINGLE sweep switchbank.
   (d) Operate TRACE LOCATE button, adjust horizontal shift and CH1 shift to centralise the horizontal trace. These controls are identified by the horizontal and vertical arrows. The inner horizontal shift control should not be pulled out to select X10 expansion.
   (e) Release TRACE LOCATE and adjust INTENSITY and FOCUS to obtain a sharply defined trace of reasonable intensity.
   If the TRACE LOCATE is operated at any time a trace will appear on the screen if the timebase is running. A spot will appear if the timebase is not triggered or X–Y has been selected as the Horizontal Mode.
   (f) If necessary, adjust TRACE ROTATION for precise alignment of trace with the centre graticule.

3.3 SETTING OF A Y CHANNEL

1. Using a coaxial lead (PL43) or suitable probe, connect a signal to CH1 or CH2 input socket and select the corresponding channel on the vertical mode switch bank.
2. (a) For direct coupling of the input signal select DC on the input coupling switch.
   (b) For coupling via the internal 0.1μF capacitor select AC.
3. (a) Adjust the VOLTS/cm switch and vertical shift to obtain the required vertical deflection.
   (b) The variable control concentric with the VOLTS/cm switch, allows continuous variation of sensitivity between the stepped ranges but when it is turned in an anticlockwise direction from its CAl position, a red warning light illuminates to show that the deflection sensitivity is no longer calibrated.
4. To locate the ground or zero volt level select GND on the input coupling switch. This open circuits the input signal and grounds the amplifier input.
5. If under this GND condition a vertical trace movement is observed on adjustment of the VOLTS/cm switch, reset the STEP BAL preset control for that channel. Access to this is through the bottom cover. This should not be done within 15 minutes of switching on.
6. Deflection which is normally positive-up may be inverted by selecting INVERT.

3.4 DUAL CHANNEL OPERATION

1. Signals applied to CH1 and CH2 inputs can be displayed simultaneously by selecting DUAL on the vertical mode switchbank. CHOP mode of beam-switching should be selected if the sweep speed is slower than about 1ms/cm and ALT (button out) at faster speeds.
2. Signals applied to CH1 and CH2 will be added algebraically onto a single trace when CH1 and CH2 are selected simultaneously. Operation of either INVERT switch will effect subtraction, displaying the difference of the two input signals.

3.5 TRIGGER VIEW OPERATION

Whatever vertical mode has been selected, pushing the TRIG VIEW button on the vertical mode switchbank will bring up another trace showing the signal in the A trigger amplifier. This applies to any trigger source except COMPOSITE, thereby giving three channel operation when the External Trigger source is selected. This facility is covered fully in section 3.8.

3.6 A TIMEBASE OPERATION

The speed of the A timebase is determined by the setting of the A TIME/cm switch. A variable TIME/cm control is fitted concentrically with the A TIME/cm switch which provides a further 3:1 (approx.) variation. When the variable control is turned in an anticlockwise direction from its switched CAL position a red warning light illuminates to show that the A timebase is no longer calibrated.

The gain of the internal X amplifier may be increased by ten times by pulling out the PULL X10 control on the inner horizontal shift control. This facility is available at all settings of the timebase but not when the X–Y mode is selected. The facility effectively increases the sweep length from 10cm to 100cm and thus allows close examination of any portion of the trace. Any portion of the increased sweep length may be selected for viewing on the display by adjusting the X shift controls (identified by horizontal arrows). The fine shift control will move the display by approximately 1cm when X10 is not selected and by 10cm in the magnified mode. A particular advantage of this facility is to increase the maximum sweep speed to 5ns/cm.

To adjust the time scale of the horizontal axis:

(a) Set the A TIME/cm switch to the required setting.

(b) If necessary, adjust the concentric VARIABLE.

3.7 A TRIGGER

The A timebase may be triggered by the following sources as selected from the TRIGGER COUPLING switch.

(a) CH1 or CH2 selects the output of the appropriate amplifier (irrespective of which beam is displayed).

(b) COMP (Composite) selects a mixture of CH1 and CH2 signals such that each channel may produce a stable trace (see note at the end of this section).

(c) LINE: The power supply line input frequency derived internally from the supply transformer.

(d) EXT: An external triggering source connected to the EXT A socket is selected when CH1 and CH2 are selected simultaneously. The sensitivity of this external input can be reduced 10 times by operation of EXT ÷ 10.

The A LEVEL control allows selection of the triggering point on the trigger waveform and hence determination of the start of the horizontal trace.

The A TRIGGER COUPLING push button switches are used in conjunction with the Trigger Source switches to connect different networks into the trigger amplifier circuit, and are effective for all settings of the Trigger Source switches.

The four switch positions for the A TRIGGER COUPLING are able to latch independently; the functions are detailed as follows:

1. Positive/Negative (marked +/–) determines whether trigger occurs as the input signal passes the selected trigger level in a positive or negative-going direction. This allows the amplifier to trigger on positive-going leading edges when positive is selected (button out) or negative-going leading edges (button pressed in).
2. DC/AC. AC (button out) coupling is useful for wideband trigger on most signals. The DC position is also a wideband trigger mode but is most useful at very low frequencies or when the mark-space ratio of a pulse signal is likely to vary. The Y input coupling must also be set to DC for this mode to be effective on internal trigger.
3. LF REJECT. A filter is switched into circuit to reject low frequencies. This allows stable triggering on the high frequency component of complex waveforms, rejecting low frequency components such as 'hum'. Note that this switch position automatically reverts the trigger amplifier to an ac coupled mode even if dc trigger has been selected.
4. HF REJECT. A dc coupled filter is switched into circuit to reject high frequencies. Low frequency triggering may be effected from complex waveforms containing high frequency components. The cross-over frequency of both the h.f. and the l.f. filters are approximately 10kHz.

NOTE: Since the composite trigger signal is taken after the beam switch, its use is relevant only on dual trace displays in the ALT (alternate CH1 and CH2) mode. Reliable triggering is obtained only with dc trigger coupling when the two traces overlap. In this mode the level control defines a point on the display rather than a level of input signal and the relative position of the trigger point on the waveforms is altered with the Y shift controls.

The main application of this trigger mode is to display two signals of unrelated frequency. Relative phase relationship is lost when displaying signals of the same or related frequency.

Triggering control is effected as follows:

1. Select an A Trigger Source push button for the required trigger signal.
2. Set the timebase to display A sweep.
3. Set the A Trigger coupling for the desired trigger input requirements.
4. Adjust the LEVEL control so that the trace starts at the required point on the waveform. The Trigger View position may be used as a guide to trigger level to assist with this setting procedure (see next section).

3.8 TRIGGER VIEW

This switch is grouped with the Vertical Mode Y channel switches. It may be latched independently and provides an extra trace for viewing the trigger signal as it passes through the A trigger amplifier. The trigger view signal may be viewed together with one or both of the selected Y signals. Display of the trigger view only is not available. Trigger view is not available when Composite trigger is selected.

The Trigger view trace has three main functions.

(a) It gives a guide to trigger level. The centre horizontal line of the graticule corresponds ap approximately to the dc level of the waveform that the trigger amplifier will select.

(b) It enables the effectiveness of the LF Rej. and HF Reg. to be observed when filtering is required on a particular signal.

(c) It enables a third Y channel to be available via the EXT A input socket when the EXT Trigger Source is selected. The trigger view trace must, however, be central on the screen for the instrument to be triggered in this mode. The A trigger level control operates as a Y shift signal on the trigger view trace.

When viewing signals from CH1 or CH2 the sensitivity of the Trigger view display is approximately that which is selected on the Y channel attenuator switches. The sensitivity to external trigger signal is approximately 50mV/cm (500mV/cm with EXT ÷ 10 selected). Bandwidth of this trace may be only half that of the two Y channels.

3.9 TRIGGER MODES (Normal, Auto and Single Sweep)

These are selected on the 3-way interlocking push button bank mounted above the vertical mode selection switches.

3.9.1 NORMAL

This mode is relevant for all trigger signals from dc to HF. The trace will blank in the absence of trigger signal.

3.9.2 AUTO

When AUTO is selected, the timebase will free-run in the absence of a correct trigger signal to display a bright line or unsynchronised display. When the TRIGGER LEVEL control is adjusted and/or the amplitude of the trigger signal is increased to obtain effective triggering, the timebase will revert automatically to normal operation. This free-run action in the absence of trigger helps in finding the trace and leads to ease of operation.

AUTO is useful for wideband signals above 40Hz. Operation below this frequency may cause mis-triggering since the timebase can revert periodically to its bright-line state.

3.9.3 SINGLE SWEEP

This facility is useful for observing a single event, particularly if a photographic record is required. By pressing the SINGLE SWEEP push button the NORMAL and AUTO buttons will be in the out position and the 'ARMED' l.e.d. indicator will illuminate showing that the timebase is ready to be triggered. On receipt of a trigger signal the timebase will operate and provide one single sweep only. To initiate further sweeps it is necessary to re-arm the timebase by pushing the single sweep button again. The single sweep facility is switched out when NORMAL or AUTO are selected again. The procedure for operating the timebase to give a single sweep is as follows:

1. Apply a repetitive waveform and obtain a trace with the sweep switch in the NORMAL mode by adjusting the A LEVEL control.
2. Press SINGLE SWEEP button and triggering should then cease. The ARMED indicator should then illuminate in readiness for the trigger signal.
3. The next trigger pulse will initiate a sweep and the l.e.d. indicator will be extinguished on completion of the sweep. The timebase will not operate again until the SINGLE SWEEP button is pressed again.

3.10 A HOLD OFF

When the A HOLD OFF control is in its normal position, switched fully anticlockwise, the hold-off circuit provides sufficient delay for the timebase to recover before the start of the next sweep. When used as a variable control its main function is to provide effective triggering on some complex waveforms. In most positions of the timebase range switch the range of hold-off variation is about equivalent to the time taken for the timebase to complete one sweep. In the case where the timebase is required to be triggered on a complex waveform (e.g. a repetitive logic pulse pattern containing pulses of different widths) then the hold-off may be used to inhibit trigger until the desired period in the waveform is reached.

To trigger on complex waveforms:

1. Adjust the A TIME/cm switch such that the repetition time of the waveform pattern is within the total time of the timebase sweep. Adjust the trigger control in the normal manner until the Trigger indicator lights.
2. Adjust the HOLD-OFF control for a stable trace.

NOTE: When triggering at high frequency, any small jitter which is visible on the trace may be removed by fine adjustment of the HOLD-OFF control.

3.11 B TIMEBASE AND TRIGGER

The speed of the B Timebase is determined by the B TIME/cm switch which, with its uncalibrated variable control, has all the ranges of the A TIME/cm switch. The B TRIGGER SOURCE selection is similar to that for the A channel but does not incorporate LINE or COMP trigger. The B TRIGGER COUPLING is also similar to the A channel but without the HF Reject push button. The B trigger level control operates in a similar manner to the A LEVEL control but incorporates the B STARTS AFTER DELAY switched position at its extreme anticlockwise position.

Note that blue coding is used against all controls relevant to the operation of this second timebase.

3.12 DUAL TIMEBASE OPERATION – NORMAL DELAYED SWEEP

To examine a small period of a stable 'A' sweep:

1. Set the B TIME/cm about two ranges faster in speed that the A TIME/cm switch.
2. Rotate the B LEVEL control fully anticlockwise to the switched position, B STARTS AFTER DELAY.
3. Set the HORIZONTAL MODE switches to A INTENS by B.
4. Adjust the INTENSITY control to observe the intensified part of the trace.
5. Adjust the B TIME/cm and the delay multiplier potentiometer so that the intensified portion covers the period of interest.
6. Set the HORIZONTAL MODE switch to the B mode when the intensified section of the previous trace will be expanded to form the full trace. Make final adjustments to the DELAY control and B TIME/cm switch to examine the point of interest as required.

3.13 DUAL TIMEBASE OPERATION – GATED SWEEP

If the display exhibits annoying jitter because of a high degree of expansion or unstable trigger of the A sweep:

1. Return to the A INTENS BY B display mode.
2. Select the appropriate trigger source, slope and coupling on the B push button switches.
3. With the B LEVEL still in the B STARTS AFTER DELAY position, adjust the DELAY control so that the bright-up starts just before the edge of the waveform selected as the B trigger point.
4. Rotate the B LEVEL control clockwise and adjust for a stable trigger by observing the bright-up which will be seen to start at the first B trigger point after the set delay.
5. Select 'B' on the HORIZONTAL MODE switch.

3.14 DUAL TIMEBASE OPERATION – A & B ALTERNATE SWEEPS

This mode provides simultaneous display of the A INTENS BY B and the B traces by switching the beam between the A and B timebase signals on alternate timebase cycles. The traces may be prevented from overlapping by use of the TRACE SEPARATION control which provides up to about ± 4cm of additional shift to the B trace only. When CH1 and CH2 are displayed in the ALT mode the trace sequence displays two A sweeps (CH1 and CH2) and the two B sweeps (CH1 and CH2).

To display A and B ALT proceed as follows:

1. Set the HORIZONTAL MODE to display A only and obtain a display using only the 'A' timebase controls.
2. Set the B TIME/cm switch two ranges faster in speed than the A TIME/cm switch.
3. Set the B LEVEL to B STARTS AFTER DELAY.
4. Press the A and B ALT switch and adjust the TRACE SEPARATION control to move the traces a reasonable distance apart. Then finally adjust the DELAY control and B TIME/cm for best display.
5. Gated sweep operation as 3.13 can be introduced if required.

3.15 X–Y MODES

Selection of X–Y mode on the HORIZONTAL MODE switch bank disables the timebase and the X deflection is derived from the selection A trigger signal. The X10 X magnification is inoperative in this mode.

1. EXT. X FUNCTION

External X operation is achieved by selection of External Trigger (simultaneous selection of CH1 and CH2) while applying the signal to the EXT. A input socket. The deflection sensitivity will be approximately 50mV/cm.(500mV/cm with EXT ÷ 10 selected). AC or dc coupling can be achieved by selection of the relevant TRIGGER COUPLING mode and the HF or LF rejection filters can be introduced if required. This external X deflection can be displayed as a single trace display against the CH1 or CH2 input, their sum or difference as selected by the VERTICAL MODE switches. Alternatively, a dual trace display of both the CH1 and the CH2 inputs against the external X signal by selection of DUAL and CHOP modes. Note that the chop signal at approximately 500kHz may become visible on signals of the smaller orders of frequency. ALTERNATE is not applicable to X–Y display.

2. X–Y FUNCTION

The full flexibility of the two Y input channels can be utilised for a single trace X–Y display by selection of CH2 as the A TRIGGER SOURCE and CH1 as the VERTICAL MODE. It is recommended that DC trigger coupling is selected without use of the LF or HF filters. AC coupling of the X signal is best achieved, by the relevant Y channel input coupling switch. In this mode X shift is achieved by horizontal shift control and the relevant (CH2) vertical shift control is inoperative. Note that the X deflection accuracy is impaired if CH1 is selected for X and CH2 for Y.

3. Y LINE FUNCTION

By using the instrument in the X–Y mode and selecting the LINE TRIGGER SOURCE switch, a display of Y versus supply line frequency may be obtained.

3.16 ADDITIONAL FACILITIES

3.16.1 USE OF PASSIVE PROBE

An X10 passive probe may be used to extend the voltage range and increase the input impedance of the Y amplifiers. The input impedance of the instrument is 1MΩ shunted by 25pF. The effective capacity of the input

lead must be added to this and the resultant impedance will sometimes load the signal source. The probe will reduce this to approximately 10pF and increase the resistance to 10MΩ. To obtain a flat frequency response it is necessary to adjust the probe capacitance to match capacitance of the oscilloscope as follows:

1. Set the VOLTS/cm switch to 20mV/cm, and the A TIME/cm switch to 0.2ms/cm.
2. Connect the probe to the 1V CAL pin.
3. Set the adjustable capacitor in the probe tip or termination, with a small screwdriver, for a square response with no overshoot or undershoot.

3.16.2 1 VOLT CAL OUTPUT

This pin provides a positive-going squarewave of 1V ±1% at approximately 1kHz. Shorting this pin to ground will give a square current waveform of 1mA in the shorting link, for current probe calibration.

3.16.3 REAR PANEL OUTPUTS

Two BNC sockets on the rear provide:

1. A ramp, a 4V positive-going sawtooth waveform, from a 10kΩ source impedance.
2. B gate, an approximately +3V level going to ground for the duration of the B sweep.

3.18.4 Z MODULATION

This 4mm socket allows dc coupled blanking to be applied to the c.r.t. The c.r.t. trace is blanked by a positive input. Negative inputs have no effect. The required amplitudes are:

(a) +1V for visible modulation.
(b) +4V for blanking at normal intensity.

The input impedance is approximately 2kΩ.

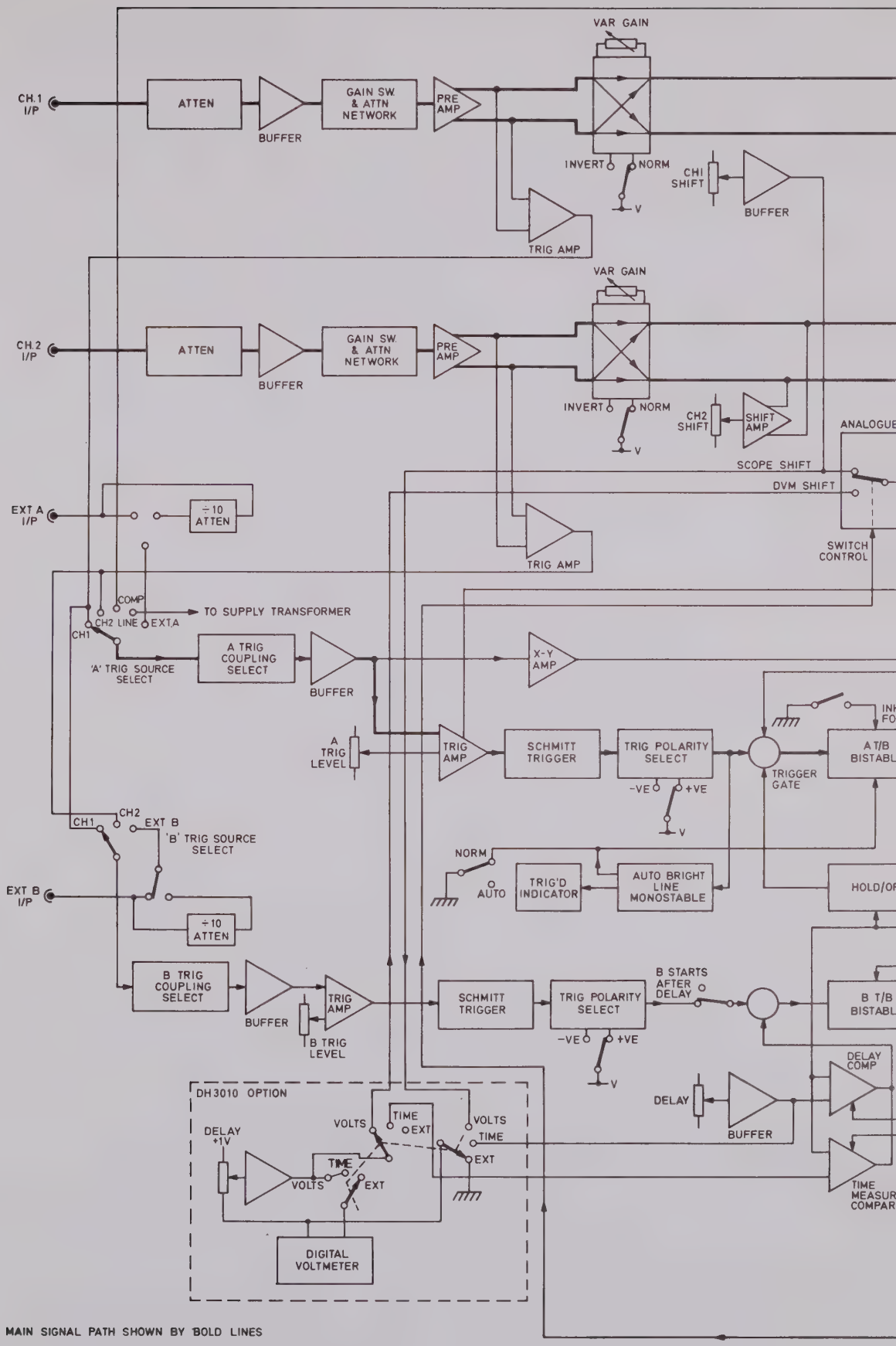
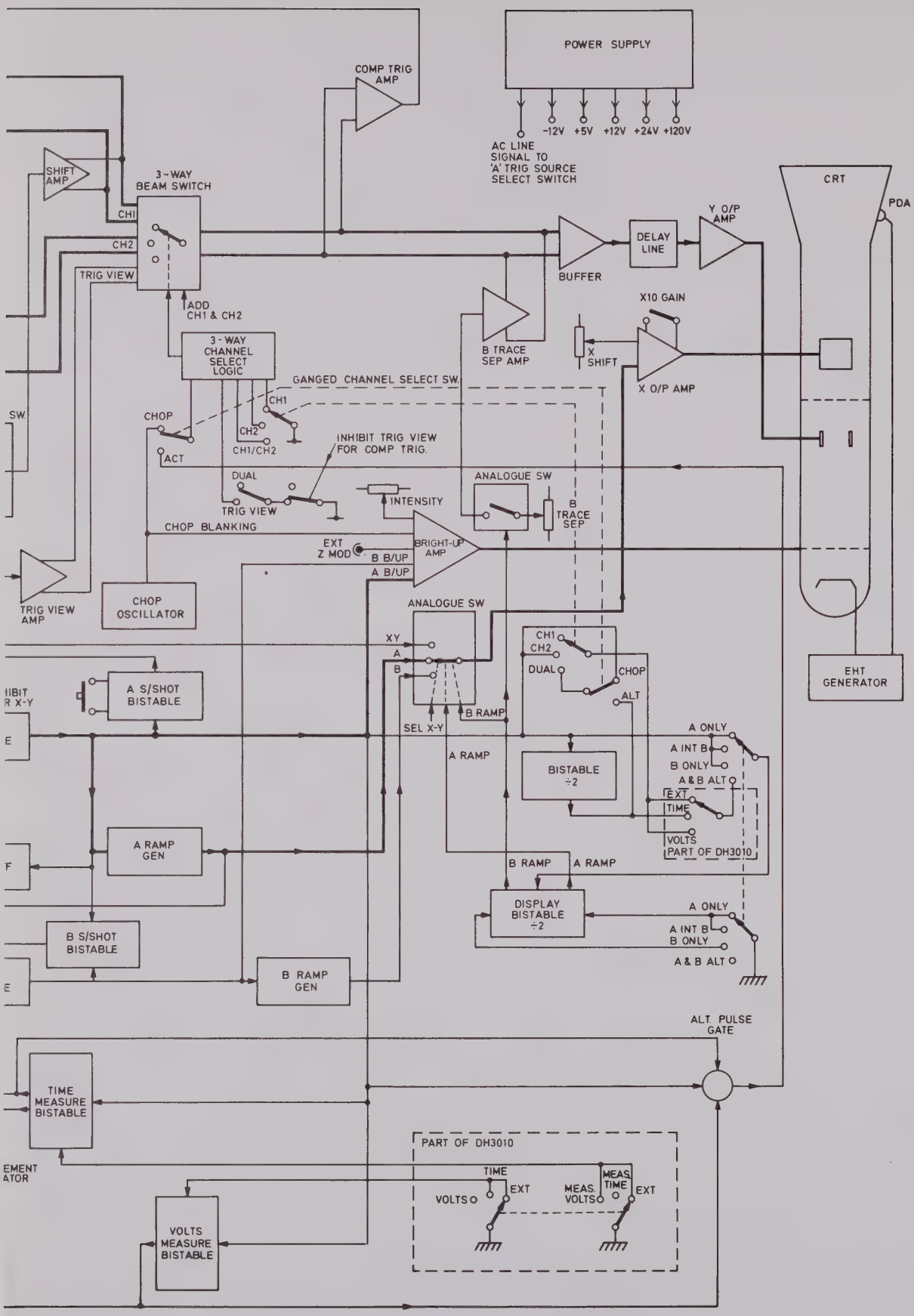


Fig. 1 Block Diagram


POWER SUPPLY
-12V +5V +12V +24V +120V
AC LINE
SIGNAL TO
'A' TRIG SOURCE
SELECT SWITCH
COMP TRIG AMP
SHIFT AMP
3-WAY BEAM SWITCH
CH1
CH2
TRIG VIEW
ADD CH1 & CH2
BUFFER
DELAY LINE
Y O/P AMP
CRT
PDA
X10 GAIN
X SHIFT
X O/P AMP
B TRACE SEP AMP
3-WAY CHANNEL SELECT LOGIC
GANGED CHANNEL SELECT SW.
CHOP
ACT
INHIBIT TRIG VIEW FOR COMP TRIG.
DUAL
TRIG VIEW
INTENSITY
ANALOGUE SW
B TRACE SEP
CHOP BLANKING
EXT Z MOD
B B/UP
A B/UP
BRIGHT-UP AMP
TRIG VIEW AMP
CHOP OSCILLATOR
EHT GENERATOR
XY
A
B
SEL X-Y
B RAMP
A RAMP
A S/SHOT BISTABLE
A RAMP GEN
B S/SHOT BISTABLE
B RAMP GEN
BISTABLE ÷2
DISPLAY BISTABLE ÷2
A ONLY
A INT B
B ONLY
A & B ALT
EXT
TIME
VOLTS
PART OF DH3010
ALT. PULSE GATE
TIME MEASURE BISTABLE
VOLTS MEASURE BISTABLE
MEAS. TIME
MEAS. VOLTS

4.1 SYSTEM DESCRIPTION

The block diagram for the instrument is shown in Fig. 1. It is not intended to be a full logic diagram but details the functional points of the circuit and their inter-relation. The circuit can readily be divided into two main sections which are the Y and X deflection circuits, the latter includes the two timebases with their associated trigger systems.

4.1.1 Y CHANNELS

The switched Attenuator, Preamplifier and Trigger Amplifiers are identical for the two Y channels. CH1 differs in having external DVM shift facilities. The state of the decade steps of attenuation and amplifier gain switching are determined by the sensitivity selected. Variable gain and Invert functions are available on each Y channel; these functions being achieved by the use of 'cold' controls applied to a single Y-stage.

The Beam Switch is a fast electronic switch with the equivalent of a change-over action. It sequentially selects the CH1, CH2 or TRIGGER VIEW signals to be passed to subsequent stages. The Beam Switch is controlled by 3 way channel select logic and has the ability to display CH1 or CH2 singly, in pairs or both CH1 and CH2 with Trigger View as a 3 trace display. Trigger View may also be displayed with either Y channel. When DUAL is selected, the channel switch logic may be controlled by the CHOP oscillator in CHOP mode or by the Alternate pulses from the A timebase bistable in the ALT. mode. In the CHOP mode the beam switch is controlled by a free running oscillator switching the beam between the CH1 and CH2 (or Trigger View) signals as the X sweep progresses. In the Alternate mode the channel select logic state is changed at the end of each timebase sweep to give CH1, CH2, (and Trigger View) during successive sweeps.

When Trigger View is selected, the chosen A Trigger signal is conveyed to the Y amplifier as a deflection signal. The centre horizontal line marked on the graticule corresponds approximately to the trigger threshold voltage. Hence, the most sensitive trigger position is obtained when the trace is adjusted to this level. Note that Trigger View when selected on its own by the Y-mode switches is also displayed with the CH1 signal.

The signal from the selected channel is passed via a delay line and amplifiers to the Y deflection plates of the c.r.t. This delay allows examination of that point in the waveform which initiated the sweep because the deflecting signal reaches the Y plates after the timebase sweep has been initiated and the trace brightened.

4.1.2 A TIMEBASE OPERATION

The purpose of the timebase system is to generate a linear ramp or ramps to deflect the spot in the X direction. The trigger system initiates each sweep from the incoming or other signals, normally to obtain a stationary display of a repeated waveform. Two timebase systems are included to allow detailed examination of a chosen section of a waveform. The A Timebase is used for simple sweeps described above and the B Timebase is introduced to provide the expansion when required.

The internal or external signal as selected is amplified by the Trigger Amplifier to drive a trigger circuit. If the timebase is ready to commence a sweep, a transition of the trigger circuit will set the 'A' Timebase bistable which in turn initiates the 'A' ramp. This signal is passed through the Sweep Select switch and X Output Amplifier to the X deflection plates of the c.r.t. At the end of the sweep, when the ramp reaches the required level the bistable is reset, returning the ramp to its original level. During the recovery period the bistable is held reset and this inhibition is maintained by the Hold Off circuit until the ramp generator is fully recovered, ready for the next sweep to commence on the next trigger pulse, when the cycle repeats.

The Bright-Up Amplifier normally holds the c.r.t. beam in the cut-off state. The output of the 'A' Bistable which allows the 'A' ramp to operate, also feeds the Bright Up Amplifier to raise the intensity of the c.r.t. spot to the level determined by the intensity control.

At the end of the sweep, this output of the bistable is reset and blanks the trace during the flyback period.

If the Y channels are being switched in the chopped mode, the output of this multivibrator is also fed to the Bright Up Amplifier to blank the trace while the Y switching transition takes place. This leaves the appearance of two separate traces for CH1 and CH2 on the screen unless the sweep speed is higher than that normally recommended for chop operation.

4.1.3 TRIGGER MODES

The trigger signal for wither timebase, selected from either channel internal, external or line frequency sources, is a.c. or d.c. coupled before being fed into the trigger amplifier. This is biased by the required trigger level and the resultant output passed to the trigger circuit to be squared up by the Schmitt trigger.

In the Auto mode, the A Timebase is made to free run in the absence of a trigger signal so giving a bright line reference when, for example, the Y inputs are grounded.

In Single Sweep, the Single Shot bistable normally inhibits trigger pulses from reaching the 'A' timebase bistable. When the bistable is set manually, the next trigger pulse initiates one sweep and the Single Shot bistable is reset, preventing the timebase from sweeping again.

4.1.4 X EXPANSION

The gain of the X Output Amplifier normally allows the ramp to deflect the spot slightly more than the full 10cm of X scan. The X10 X Expansion increases this gain accordingly giving a full sweep display of greater than 100cm and the X shift control determines which 10cm portion of this appears on the screen. This facility is available on all timebase modes of display, but not on XY.

4.1.5 B TIMEBASE OPERATION

'A' INTENSIFIED BY B ('B' STARTS AFTER DELAY)
In this mode of operation the 'A' ramp is the same as for 'A' only. The 'B' timebase bistable is switched on at the required point in the 'A' sweep when the 'A' ramp reaches the potential set by the delay control and detected by the Delay Comparator. The 'B' ramp generator then runs either for its full period or until the end of the 'A' ramp, whichever occurs first, when the 'B' bistable is reset. The 'B' single shot bistable ensures that there is only one 'B' sweep during any one 'A' sweep. The output of the 'B' bistable drives the Bright Up Amplifier to brighten the 'B' portion of the 'A' trace above the normal level. This mode is used to identify a portion of the trace for subsequent expansion in the B Only mode.

'A' INTENSIFIED BY 'B' (GATED)
This mode of operation is similar to 'B starts after delay' above, but the B timebase bistable is set only on the receipt of the first B trigger signal after the end of the set delay period, thus synchronising the B sweep to the B trigger signal.

'B' ONLY
In this mode, the 'A' and 'B' timebase systems operate as for 'A Intensified by B' above, but the B sweep is selected by the X Select Switch and the trace is turned on only during the B sweep. The effect on the display is to select and expand the original intensified portion of the 'A' Intensified by 'B' trace to fill the full screen.

'A' AND 'B' ALTERNATE
This mode displays the A ramp and B ramp on alternate sweeps. The first sweep provides an A intensified by B trace, where the A sweep is selected for the X amplifier input, and the B ramp generator provides and intensified trace when the A ramp reaches the position set by the Delay control. On the next A sweep, the B ramp signal is selected to be fed to the X amplifier, and bright up is provided only during the period of B sweep. On this sweep, an additional shift signal controlled by the Trace Separation control is gated into the Y amplifier. This control allows the B trace to be separated from the A intensified trace by up to ±4cms.

4.1.6 X-Y MODE
When this mode is selected, the timebase system is inhibited and the Sweep Select switch connects the A Trigger signal to the X Output amplifier as the X deflection signal. Trigger source selection allows the CH1, CH2, External or Line signal to be chosen. Both Y channels may be displayed in X-Y by selecting CHOP mode.

4.1.7 DIGITAL MEASURING UNIT
This optional addition to the OS3600, the DM3010, contains a digital multimeter which can operate independently to measure d.c. voltage, current or resistance. In addition, it can operate with the OS3600 to provide digital readout of parameters displayed on the screen.

VOLTAGE MEASUREMENT
In this mode, the 0V of the DM3010 is connected to the CH1 shift voltage of the OS3600 and an additional shift voltage is generated within the DM3010, determined by the V/T control.

An electronic switch controlled by the Volt Measure Bistable selects as CH1 shift on alternate sweeps, either the normal CH1 shift signal or this additional offset signal. The effect is to produce two traces with an offset which can be set by the V/T control. The DM3010 measures this voltage and scales it according to the CH1 sensitivity chosen, to display the offset directly as a voltage.

TIME MEASUREMENT
In this mode, the 0V of the DM3010 is connected to the delay level set within the dual timebase system of the OS3600. The V/T control determines an offset voltage which is applied to an additional comparator on the A ramp. The output from the normal Delay Comparator or that from the Time Measurement comparator is selected by the Time Measurement Bistable on alternate A sweeps as the signal to initiate the B sweep. The effect is to produce delayed B sweeps at two positions along the A sweep. The time difference between them is indicated as the voltage measured by the DM3010 after automatic scaling according to the Time/cm set on the OS3600.

In the 1/Time or Frequency mode of operation, the measured and reference voltages of the DM3010 are reversed, inverting its reading for it to display the frequency equivalent to the selected time. The control logic inhibits the simultaneous selection of voltage and Time (or Frequency) measurement to avoid a confusing display. A maximum of 6 traces in the absence of time or voltage measurement may be displayed if A and B Alternate is selected, together with CH1, CH2 and Trigger View. The selection of time measurement will then provide the usual extra bright up signals and B sweeps on these six traces corresponding to the levels set up by the DELAY and V/T controls.

4.2 Y AMPLIFICATION

4.2.1 ATTENUATORS AND PRE-AMPLIFIERS
NOTE: The attenuators and pre-amplifiers in the Channel 1 (CH1) circuit are identical to those in Channel 2 (CH2). Accordingly, only CH1 is described. The component numbers in CH1 have an equivalent component in CH2. The odd numbered components off the p.c.b. are in CH1 and even numbered in CH2. On the p.c.b., 100 series numbers are CH1 and 200 series CH2.

The Y input signal is applied via the BNC socket on the front panel and routed to the AC/DC switch S11. In the DC mode, the signal passes, via R49 and C51 in parallel, to the NORMAL/GROUND switch S13, which, when released, passes the signal to the input attenuator selector S9dB. In the AC mode, the DC path via R49 is interrupted by C53.

The input attenuator consists of three fixed networks, giving attenuation ratios of 1, 10 and 100 : 1.

R71, R73, C61, C65 (X10) and R75, R77, C63, C67 (X100) form conventional wideband attenuator networks. C69, C71, C73 adjust the input capacitance on X1, X10 and X100 respectively. The remaining components control the pulse damping of the attenuators. S9dB selects the appropriate attenuator outputs, which is routed via the input protection circuit formed by D102, D104 and zener diodes D101 and D103, to the gate of f.e.t. TR101.

The current required to drive the low impedance section of the attenuator is provided by source follower TR101, and emitter follower TR103. D.C. drift in this section is corrected by a closed-loop circuit including bi-fet op-amp IC101. R79 and R85 tap off 90% of the input signal, which is applied to IC101 and compared with a fraction of the emitter follower output via R178. The error voltage thus produced is used to control the f.e.t. source current, via TR102. Thus, the gate/source voltage of TR101 is adjusted for zero d.c. offset. Pre-set R178 adjusts the fraction of the output fed back to IC101, to equalize the a.c. and d.c. gains of this section. Filter R110 and C103 ensure loop stability. R179 corrects for d.c. offset in IC101, thus acting as an attenuator balance control.

The output from TR103 drives the low impedance section of the gain switching film network R83, which provides the 1-2-5 sequence of gain steps between the X1, X10 and X100 steps of the input attenuator. R836 provides a X10 position which is used on 5V/cm only. The 2mV/cm range uses the 5mV/cm attenuator settings, but the basic amplifier gain is increased by shunting the emitter circuit of dual transistor IC102. The following table shows the complete range switch sequence.

Input Attenuator	Film Network R83			
	g	e/f	d	b
X1	*2mV/5mV	10mV	20mV	
X10	50mV	0.1V	0.2V	
X100	0.5V	1V	2V	5V

*S9df closed

Long-tailed pair IC102 provides the first stage of amplification. R183 allows independent calibration of the 2mV range, and the frequency response on this range is adjusted by A.O.T. capacitor C107.

R180 compensates for any D.C. offset at the emitters of IC102, thus providing d.c. balance for the 2mV range switching.

The next stage is a conventional grounded base amplifier, with R182 correcting the d.c. offset to the following inverting stage. Two differential outputs are taken from TR104 and 105 collectors, one via R87 and 89 to the trigger pre-amplifier, the other via R130 and 131 to the inverting and gain control stage.

IC103 is coupled to form a balanced modulator. The circuit is basically a cascode amplifier, with the upper section split to form an emitter switch. If the voltage at pin 3 is substantially higher than at pin 8, the signal is steered to the collectors at pins 1 and 10. Reversing the voltages at pins 3 and 8 by operating S101 directs the signal to the collectors at pins 2 and 9, which feed the output in opposite phase from pins 1 and 10. With variable gain control R13 in the 'CAL' position the voltage between pins 3 and 8 is sufficient to ensure that virtually all the signal passes in the forward or reverse direction as appropriate. As R13 is turned away from the Cal position, the voltage between pins 3 and 8 is reduced, and the signal from one pair of collectors is partially offset by an inverted signal from the other pair. In this condition, switch S7 on R13 operates l.e.d. D15, to warn the operator that the channel is uncalibrated. Emitter follower TR112 provides a fixed d.c. reference, to maintain the correct mean d.c. level at pins 3 and 8. Pre-set R181, between the emitters of the lower section of IC103, sets the overall calibration of this channel.

Transistor array IC104 provides further amplification and Y shift. Sections c and d form a conventional grounded base stage. A long tailed pair formed by sections a and e convert the shift control voltage at pins 2 and 12 into a differential current signal, which is added to the main Y signal at the emitters of the grounded base stage.

To allow for the optional DVM unit on CH1, the derivation of the shift control voltage differs between the two channels. On CH2 the voltage is simply the attenuated output of shift control R12, while on CH1 it is necessary:-

a) To add the shift voltage from the DVM to the manual shift voltage on alternate timebase sweeps.

b) To adjust the shift sensitivity at this point to exactly 0.4 volts/cm for DVM calibration.

Pin 12 of IC104 is held at -4.7 volts by zener diode D109. Pin 2 is driven by emitter follower TR106 and the sensitivity at this point is set by pre-set R185. The control voltage from shift pot R is buffered by TR107 and sent via PLM pin 5 to the DVM, which adds a measured voltage and returns it via PLM pin 4. An analogue gate, IC106, connects the base of TR106 to the manual shift voltage, via pins 10 and 11, or manual plus DVM shift voltage via pins 8 and 9. The control pins 6 and 12 are operated via TR108 and 109 by signals from the timebase logic, at PLM pins 1 and 3, to give direct and DVM shift on alternate timebase sweeps.

The combined Y signal and shift output at pins 8 and 11 of IC104 passes on to the beam switch, along with the corresponding output from CH2, and an output from the trigger amplifier for trigger view. Each section of the beam switch is based on a transistor array similar to the

ones used for invert and gain control. The lower section of the IC forms a common emitter amplifier with frequency compensating components between emitters. Trimmer C125 serves to equalize the frequency responses of the Y channels. Beam switching is carried out by the upper common base section. If pin 8 of IC107 is at a higher voltage than pin 3, the signal passes via pins 2 and 9 R368, R369, to the common output for the 3 channels. Reversing the control signals on pins 3 and 8 steers the signal to pins 1 and 10, where it is discarded by short-circuiting into the supply rail. This system causes the standing emitter currents, as well as the required signal, to be switched from output to supply line. In all modes except ADD, only one of the three beam switches is active at any instant. However, in ADD mode, CH1 and CH2 are both active, and the common signal rail receives twice as much standing current as in other modes. To compensate for this, when PLM pin 12 goes high to select ADD mode, an emitter switch (section a and b of IC307) causes emitter follower (section d of IC307) to feed extra current into the common signal rail via R390 and 391. The emitter follower output also switches on section c of this IC via R392 and D301. This removes the current which previously passed through D310 to the trigger view beam switch emitters, thus increasing the collector current of this stage to match the combined currents of CH1 and CH2. Thus if ADD and trigger view modes are selected, the current into the common signal rail is constant during beam switching. Trigger view input to the beam switch differs slightly from CH1 and CH2, in the provision of A.O.T. resistor R1369 which adjusts trigger view gain to match the main Y channels, and d.c. offset control R382, which sets the trigger point to centre screen in trigger view.

In all multi-trace modes, the required beam switches are scanned by the beam switch logic at a sufficiently high frequency to give the appearance of a set of steady traces. The mode switches control the beam switch logic via 6 lines of PLM, according to the following truth table.

PLM pin 18 (ALT · $\overline{\text{X-Y}}$) is primarily the ALTERNATE mode select line. Since the timebase is not running in X-Y mode, ALTERNATE cannot be used, and interconnections on the push buttons automatically select 'CHOP' mode.

Above lines are directly controlled by the mode switch push buttons. Two further logic lines are decoded by the beam switch logic, and passed via PLM to the timebase logic.

PLM Pin 19 (SINGLE TRACE) High on all single trace modes, i.e. CH1, CH2, or ADD.

PLM Pin 9 (CHANNEL PHASE) Relays the status of the beam switch bistable in ALTERNATE modes.

The beam switch logic is based on a ÷2 or ÷3 counter formed by IC306 and IC304a, clocked by a multivibrator IC304b and c, in chop mode, or by the end of sweep pulse from the timebase in alternate mode.

In all two trace modes, PLM pin 16 is high, and IC304a holds the $\overline{\text{KI}}$ input of IC306 low. $\overline{\text{JI}}$ which has no external connection is held low by an internal resistor. With $\overline{\text{JI}}$ AND $\overline{\text{KI}}$ both low, the first section is in "toggle" mode, i.e. Q1 and $\overline{\text{Q}}$1 reverse on each clock cycle. The second stage, which is connected as a shift register, follows these changes one cycle later, thus producing complementary ÷2 outputs at Q1 and Q2 (IC306 pins 2 and 15). When 3 traces are required, PLM pin 16 is low, and the inverted feedback from Q2 via IC304a to $\overline{\text{KI}}$ produces a ÷3 counter with the following phases:-

	∅1	∅2	∅3
Q1	0	1	1
Q2	1	0	1

Q1 and Q1 outputs and the control lines from PLM are decoded by the ECL gates of IC303, IC304, IC305 and drive the beam switches via their complementary outputs. To simplify the decoding of single trace modes, on

LOGICAL FUNCTION OF CONTROL LINE	PLM PIN	MODE CH1	CH2	DUAL	ADD	CH1 & T/V	CH2 & T/V	DUAL & T/V	ADD & T/V
ADD	12	0	0	0	1	0	0	0	1
CH1	13	1	0	0	0	1	0	0	0
CH2 + ADD	14	0	1	0	1	0	0	0	0
$\overline{\text{3 CHANNELS}}$	16	1	1	1	1	1	1	0	1
T/V	17	1	1	1	1	0	0	0	0

CH2 or ADD modes, the second section of IC306 is held in its reset state via PLM pin 14.

The chop oscillator is formed by IC304b and c, and positive feedback components C310 and R366. This produces, at IC304 pin 3, a square wave output of approximately 1MHz, which is used to clock the beam switch logic, and also via buffer transistor, TR311, to blank the c.r.t. beam during switching. If IC304 pin 10 is held high, the oscillator is stopped, by clamping IC304c low and the output of IC304b is controlled by the alternate pulse from the timebase, via D311 and R359. This will occur:-

a) When "ALTERNATE" mode is selected. PLM pin 18 is high (unless X-Y mode, which automatically selects "CHOP", is used) and stops the oscillator via D305.

or

b) in any "SINGLE TRACE" mode, D303, 307, 309 and TR307 decode the control lines on PLM pin 13, 14 and 17 to produce a logic 1 level, which stops the oscillator via D308. "SINGLE TRACE MODE" information is also passed to the timebase. via PLM pin 19.

In alternate, multi-trace modes, it is necessary for the state of IC306 Q2 output to be available to the timebase, to allow proper sequencing of the DVM system. TR308 and D306 decode PLM lines 18 and 19 to detect "alternate and not single trace" condition. The Q2 output passing through IC303a is shifted to TTL levels by TR309 and 310 and sent via PLM pin 9 to the timebase.

The combined output from the beam switch system drives a common base amplifier TR318 and 319. A shift signal from the timebase is added at this stage via R345 and 346. This signal is used to separate the traces for A and B timebase sweeps in "A and B alternate" mode.

The next stage is essentially a cascode amplifier, using TR312 and IC302, but a pre-set gain control R367 is included between common emitter and common base sections, to compensate for gain tolerances in the subsequent stages, and limit overdriving of the output module.

IC302 output is adjusted for d.c. offset by R341 and used to drive the delay line L2. R344 provides the correct terminating impedance of 180Ω for the delay line. A second output from IC302 buffered by common emitter stage TR305, 306, provides the Composit Trigger output. R356 allows for d.c. offset in this stage.

NOTE: Interconnection between "COMPOSITE TRIGGER" and "TRIGGER VIEW" push buttons prevent these two functions from being selected simultaneously, which would effectively connect the output of the trigger amplifier to its own input. If this is attempted, "COMPOSITE TRIGGER" is selected, and "TRIGGER VIEW" is suppressed.

R401-404 terminate the delay line to drive common base stage TR401 and TR402. Common emmitter stage TR403 and TR404 provides a constant current output to drive the output module. R456 adjusts the common mode current into the output module, to set the mean plate potential on the c.r.t. R-C networks between TR403 and TR404 emitters provide frequency compensation to offset the capacitive load of the c.r.t. The tail current for this stage is normally derived from the -12 volt rail via D404. However, if "TRACE LOCATE" button S400 is operated, this supply is disconnected and a reduced current is provided via R452. This current allows the stage to operate but is not sufficient to drive the trace off screen.

C.R.T. driver IC471 consists of a differential shunt feedback stage with virtual earth inputs to pins 1 and 5, followed by an open collector cascode output stage. To improve the drive capability at high frequencies the shunting effect of collector supply resistors R473 and R474 is relieved by RF chokes L471 and 472. IC471 requires a +7V supply, which is provided by regulator IC472. The output of IC471 passes via stopper resistors R38 and 39 to the Y plates of the c.r.t.

4.3 TRIGGER

4.3.1 TRIGGER SELECTORS

The trigger source for Timebase A is selected by operation of one of the interlocked switches S508, S509, S510, S511 or S512.

The Composite CH1 and CH2 signals are generated at 50Ω impedance on the pre-amplifier board and fed via co-axial cables to S511, S510, S509 respectively. The line signal applied to S512 is derived from a secondary of the supply transformer and fed via pin 601 and a potential divider R665 and R664. C584 removes any unwanted high frequency interference.

The External input signal is fed via a high impedance potential divider with a division ratio of 2.5:1 consisting of R661 and R674 as the series element and R501 (connected across S504) as the parallel element. Input capacitance is set by C589 and frequency compensation by C586 and C588.

C587 acts as a capacitance pad when the EXT. ÷ 10 is selected. The output from this attenuator is conveyed to the Trigger Source switch via pt. 622, R23 and pt. 610 to S508a. When S508 is in the out position and CH1 and CH2 are both selected to give the External function, the signal passes via S508a, S509a, S510a, R578 and R662 to connect to the main trigger amplifier board coupling switches and R501. The sensitivity with S508 in this position is 50mV/cm approx. If, however, S508 is selected, a further ÷ 10 attenuator is inserted in the signal path consisting of R675, R660, C545, C546 and C547 fed via the low impedance network R622 and C548. The EXT. X sensitivity is 500mV/cm for this position of S508.

A selected trigger source, CH1, CH2, Composite, Line or EXT. is then conveyed to the trigger coupling switches via the link from pin 602 on the trigger source board to pin 507 on the main trigger amplifier board,

The switches S501, S502, S503 and S504 all operate independently. The function of the Slope switch, S501, will be described later (Section 4.3.2).

When D.C. only is selected, the signal from pin 507 is routed directly through S503, R599, S502 and S504 to the gate of TR501, the A trigger amplifier. When A.C. coupling is selected by S502, C543 is introduced into the circuit for wideband A.C. coupling. When L.F. Reject is selected by S503, a much smaller capacitor, C542, is introduced, allowing through only the high frequency components of the trigger signal.

When HF Reject is selected, R598 is introduced into the circuit with C514 to ground as a filter to reject high frequency components of the trigger signal.

The B selection and coupling circuitry is similar to that described above for A and is based on S513, S514, S515, S505, S506 and S507. This timebase does not have facilities for Line source, Composite source or A.C. LF rejection coupling.

4.3.2 TRIGGER AMPLIFIERS

The input stage of the amplifier circuit is formed by f.e.t.'s TR501 and TR502. Resistor R501 determines the input impedance of approximately 470k ohms.

Field effect transistors TR501/TR502 are a dual matched pair in a single package. TR501 acts as a source follower and TR502 acts as a constant current load which provides drift correction. R504 and R505 define the source current in each f.e.t., and R506 is an HF stopper.

The f.e.t. stage drives TR503, an emitter follower with two output paths; one from its emitter to the emitter of TR505, via R515 and out to the External X amplifier circuit, the other via R529 to the base of TR507, in the trigger amplifer.

For X-Y operation, the output passes through R515 to the emitter of the common base connected amplifier TR505. The output from the collector of this transistor is applied to emitter follower TR506. Resistors R510, R511 and R512 provide the emitter load, with shunt feedback from the junction of these resistors back to the base of TR505. The circuit gain is this approximately 2 and adjusted by R512. Resistor R514 provides an offset current into the base of TR505, to bias the output voltage at TR506 emitter at 2.0V. Capacitor C506 connected across the base collector junction of TR506 provides a high frequency roll-off to compensate for the delay introduced by the 'Y' Amplifier delay line. The value of this capacitor is determined during initial testing of the oscilloscope. The output from the emitter of TR506 is passed to the X-Y output at PLP pin 10 via R516.

When the X-Y function is not in use, an inhibit signal is applied from socket PLP pin 3. This is in the form of a -12V level applied through R517 to the cathode of D502. This diode is then made to conduct and draws current from R510, R511 and potentiometer R512, thus cutting off TR505 and preventing any output to the X amplifier circuit. With TR505 cut off, the tail current of TR503 will now flow through R515 and R513 in parallel with R507.

To prevent the trigger amplifier TR507/TR508 drawing current from R515 and affecting the X-Y output when X-Y is in operation, an additional inhibit signal of +12V is applied at socket PLP pin 1. This is passed via zener diode D503 and R534 to the emitters of TR507 and TR508, cutting off this stage.

During normal trigger operation, the output from TR503 emitter is applied to the base of TR507. This transistor forms a differential amplifier with TR508. The base bias for TR508 (-0.8V) is provided by the ntework R524, diode-connected TR504 and R525. This voltage is adjusted by potentiometers R520 and R522, via R521 and R523 respectively. R522 is the main Trigger level control, R520 provides additional bias to balance the amplifier when the A Trig Level control, R522, is central. The gain of the stage is controlled by R528, with frequency compensation provided by R527 and C509, C508.

Outputs from the collectors of TR507 and TR508 are applied to the emitter followers TR511 and TR512 via R548 and R549 respectively. These emitter followers perform the dual purpose of driving the trigger amplifier and the Trigger View signal to the Y amplifier via PLR and the matching resistors R550 and R551. When Trigger View is not required, the signal is prevented from feeding the Y amplifier by the diode gate D516 and D517. The gate is controlled by S713 on the timebase circuit via D514. The normal trigger signal from the emitter followers TR511 and TR512 is fed to the rest of the trigger amplifier via R538 and R539 to the bases of TR509 and TR510. The gain of this stage is determined by the values of R540 and R541 and frequency compensation is provided by C518.

Transistor TR509 feeds the base of TR513 via R558, and TR510 feeds the base of TR514 via R559. This differential amplifier forms the final amplifier stage prior to the Schmitt trigger input.

Circuit gain is determined by the values of emitter resistors R562 and R563, and frequency compensation is provided by R556 and C516. The common tail current flows through R561 and R536 to the -12V rail, and C517 de couples the junction of these resistors at HF.

Transistor TR514 is biased such that its collector is at 3.9V, which is the threshold voltage of an Emitter Coupled Logic (ECL) input signal. A 'high' normally being at 4.4V and a 'low' at 3.4V.

The ECL line receiver package, IC501, is used as the

Schmitt trigger circuit. The signal input is applied to the non-inverting input pin 13 and positive feedback is applied from pin 14 to pin 12 via R569 and C522. R567 is connected to the ECL bias voltage at pin 11 which sits at the logic threshold, (3.9V). The Schmitt sensitivity is determined by the ratio of R567 and R569 and the output signal at pin 14. High frequency performance is improved by the network R557 and C521.

The non-inverted output from pin 15 drives the stage IC501a via its inverting input and IC501b via its non-inverting input. IC501a is used to detect positive trigger slopes and IC501b to detect negative trigger slopes.

When the Trigger Slope switch S501 is set for negative slope, a positive bias is applied to the network R572, R573, R575 and R576, to enable IC501b and cut off IC501c, inverting the trigger output signal. Conversely, for positive slope, this bias is removed, IC501a is enabled, IC501b is cut off and the non-inverted trigger signal is transmitted.

The trigger amplifier of the B timebase is similar to that described above for A, but does not have the XY or trigger view output stages. The input stage is formed by the source follower TR520 and emitter follower TR522. This drives the amplifier TR524, TR525 for comparison against the trigger level defined by R612 with preset R610 for balance. Subsequently, differential amplifier stages TR526, TR527 and TR528; TR529 are used to drive the Schmitt trigger IC502c with slope selection as IC501.

4.3.3 TRIGGER DETECTOR

The buffered output from the A trigger circuit is coupled by C536 into the trigger detector circuit comprising TR515, TR516, TR517 and TR518. The purpose of this circuit is to detect the presence of trigger signals driving the l.e.d. indicator and controlling the timebase in the Auto mode. The square or polsed waveform from IC501 is differentiated by C536, amplified by TR515 and fed by C533 to a diode detector circuit comprising D508 and D509, with bias provided by D510.

Each resultant negative transition is coupled via D508 into the monostable TR516 and TR517. In the absence of input, both transistors are cut off. A single trigger signal or transition will turn TR516 and TR517 on for a period of approximately 30ms determined by C531, C532 and R587. The output from the emitter of TR517 turns on for a period of approx. 30ms determined by C531, C532 and R587. The output from the emitter of TR517 turns on TR518 to energise the indicator D515. A continual succession of trigger signals above approx. 40Hz eill hold the monostable in the on state and the indicator will be energised continuously. The additional output from the collector of TR518 is taken via R595 and PLP pin 3 to the timebase circuit. This is normally near to 0V in the absence of trigger signals but goes low in the presence of trigger signals to inhibit the timebase from free-running.

4.4 TIMEBASE

4.4.1 A RAMP GENERATOR

Each ramp generator is controlled by a bistable which is turned on by a valid trigger or other signal to start a sweep, and turned off at the end of each sweep to await the next start. The bistable for the A timebase is IC701b.

The triggering input, from IC501 on the trigger board, is applied to the Clock input of IC701b at pin 11. If the D input of IC701b is assumed to be high at this time, controlled by IC702c output at pin 15, then the Q output at pin 15 of IC701b will go high and $\overline{Q}$ at pin 14 low on receipt of a positive edge clock pulse.

The Q and $\overline{Q}$ outputs of IC701b feed the bases of transistors TR702 and TR704 connected as a long-tailed differential amplifier. With the Q output high, TR702 conducts and TR704 is turned off.

The principal operation of the ramp generator is the charging of a selected timing capacitor from a constant current source TR714. The linear voltage rise is fed into a buffer amplifier and before a ramp starts, a feedback loop stabilises this output to ground by drawing off a current via the fly back transistor TR710 which equates the charge current.

In detail, TR702 collector is coupled via R736 to the emitter of the fly-back transistor TR710. When TR702 is turned on, TR710 is cut off and TR702 draws its emitter current from R749. D713 and Zener diode D712 limit the reverse bias on the base emitter junction of TR710. As TR710 is turned off, the constant current source provided by TR714 starts to charge the timing capacitors C721 and C722 with C719 and C720 if selected. Selection of the timing capacitor and resistor value RT from the resistor network RN is done by the A TIME/CM switch S3. The timing capacitors C719 or C720 are brought into circuit by transistors IC711d and IC711c for the following conditions:- C719 is in circuit when a low timebase velocity range is selected by S3. In this position, S3 provides a positive voltage from the +12V line to the base of IC711d via resistor R753, which saturates IC711d and so connects one end of C719 to ground. In a similar manner, C720 is selected on the mid range timebase velocities, S3 now providing a positive voltage via R754 to the base of IC711c. To ensure that they are cut off when not selected, the bases of IC711d and IC711c are held at approx −4V vy R742, R746 and R754, R747 respectively. R758, R759 and D717, D719 are used to 'bootstrap' the output ramp to the collectors of the transistors IC711d and IC711c, ensuring that they do not drop significantly below 0V when the timebase ramp voltage is near zero. Resistor R776 and capacitor C714 at the base of IC711d remove any charge remaining in C719 when switching to a higher velocity range.

The trimmer capacitor C722 allows calibration of the high velocity ranges when neither C719 nor C720 are selected. Note that on the mid ranges when IC711c is on and IC711d is off, C719 remains in series with C720 and their values are chosen accordingly.

The charging current from TR714 is determined by the value of RT, as selected by S3 its emitter voltage with respect to the +24V supply. The base voltage is fed from the the emitter follower TR715 as determined by the potential divider network R765, R766, R780, R760 and R769 and potentiometer R767. R767 is used as the main TIME/cm calibration adjustment to set the timing currents accurately for the mid-timebase ranges when the close tolerance capacitor C720 is in circuit. TR713 is normally off but, like IC711d, it is turned on when the low velocity ranges are selected and R761 is effective to allow calibration of these ranges. D716 is reverse biased when these ranges are not selected so that R761 has no effect on calibration.

The variable sweep speed control R7 operates via the components R768, D714, D715 and TR716. In the calibrated position, the wiper of the control connects pin 4 directly to pin 7, and the associated switch S5 is open. TR716 simply acts as an emitter follower defining current in R7 but not presenting an appreciable load to the sweep rate control level at the emitter of TR715. As R7 is turned away from its end stop, S5 closes to energise the UNCAL indicator D12. After a small movement along the track, the voltage between pins 4 and 7 will exceed the necessary drop across D714 and D715 and current will be drawn through R768. Further movement of the Variable control R7 will cause the current in R768 to exceed that in R764. TR715 will be cut off and the control voltage on the base of TR714 will rise under the control of R7, reducing the voltage across RT and hence reducing the charging current to slow the ramp rate as required.

The ramp voltage is monitored at the gate of f.e.t. TR717 acting as a source follower. TR718, in the same package, provides a constant current source for TR717. As the two f.e.t.'s are almost identical and the gate of TR718 is strapped to its source, TR717 is biased automatically for near zero gate-to-source voltage. The ramp output from TR717 is further buffered by emitter followers TR719 and TR720. The output from TR719 is coupled via D719 and applied to the X selector switch IC709b and via R778 to the Ramp Output socket on the rear panel. This signal is also applied via the divider network R729, R711 and R713 to the gate IC702a. When the cathode of D719 reaches approx. +4.4V this gate switches to apply a clear signal to the A timebase bistable IC701b and complete the sweep.

With IC701b reset, TR702 is cut off and TR704 conducts. TR710 conducts as a constant current source to exceed the charging current from TR714 and the ramp voltage returns rapidly toward 0V, i.e. 'flyback' occurs. When the ramp output from TR720 reaches this level, TR723 comes into conduction and its collector current diverts emitter current from TR710. TR722 and TR723 form a comparator and the loop stabilises the ramp voltage ready to start the next sweep. TR711 conducts only as the ramp reaches its 0V level on fast flyback rates and prevents overshoot of the start point. The ramp output from TR717 is coupled to emitter followers TR719 and TR720 which are used to buffer the ramp output to the X amplifier and delay comparators IC710a and 710b.

4.4.2 HOLD-OFF

The hold-off circuitry is provided to enable the ramp generator to recover fully at the end of its sweep before another sweep commences. It also allows the 'X' Amplifier to stabilise. The period during which the timebase is prevented from triggering can be varied by operation of the HOLD-OFF control. This allows stable triggering from complex waveforms.

The hold-off system operates in a similar manner to the timebase ramp generator. It contains two constant current sources. TR571 charges one of the hold-off capacitors C710, C712, C713 as selected by the A TIME/cm switch S3. The other constant current source TR721 acts as a flyback transistor to discharge the hold-off capacitors. The voltage on the selected hold-off capacitor turns on TR712 when the potential drops below about 3.6V. The emitter current from the emitter follower TR719 flows through D719 and the potential divider R748 and R770. When the ramp output is rising and reaches about 2V (Approx. ½ ramp period) the potential across the junction of R748 and R770 exceeds the forward potential of D710 and the emitter voltage of TR721, thus turning the flyback source off. This enables the current source TR751 to charge the selected timing capacitor. C712 and C713 are selected by IC711a and IC711b in a similar manner to the timebase capacitors C719 and C720 described previously.

As the hold-off potential goes positive, TR712 is cut off and a logic low is applied to the OR gate IC702c. Positive feedback is applied via R727 and C706 so that a rapid transistion occurs at the output of this gate.

The output of IC702c is applied to the NOR gate IC702d at pin 13. Because the other input of this gate, at pin 12, is the Q output of IC701b, which is high during positive excursions of the timebase ramp, then a logic high is fed from pin 15 of IC702d to the D input of IC701b. The Q output of bistable IC701b therefore remains high, since further clock pulses cannot change its state.

When the ramp has reached its maximum positive (4.4V) level and reset occurs as previously described, the flyback commences. As the flyback continues the ramp output voltage falls and at approximately 2V, diode D710, controlled by the voltage at the junction of R748 and R770 cuts off. This allows TR721 to conduct and discharge the hold-off capacitors via R737.

Variable hold-off is achieved by varying the emitter current of TR721 from the HOLD-OFF control on the trigger p.c.b. via R741. This controls the ramp amplitude seen at the base of TR712 and so varies the hold-off time. Delay periods of up to one timebase period can be achieved.

As a result of the hold off flyback transistor being switched off when the timebase ramp amplitude exceeds 2V, charging of the hold off capacitors C710, C712 and C713 continues until about half of the ramp flyback period has occurred. When the ramp voltage has dropped below 2V the flyback current source conducts again discharging the hold-off capacitors. The discharge period continues well beyond the ramp flyback period until the voltage on the hold-off capacitor has dropped sufficiently to turn on TR712. When the main timebase bistable IC701b switches over driving the Q output low at pin 15 at the commencement of the timebase flyback period, the output of the gate IC702d pin 15 drops low. This puts a low on pin 10 of IC701b, hence further clock pulses do not change the state of the bistable. At the end of the hold off period when TR712 has turned on, the output of IC702d pin 15 is brought high again via the signal from IC702c. This results in a high being applied to pin 10 of IC701b in readiness for the next trigger signal to start another ramp. A negative going signal edge from IC702d pin 9 to capacitor C773 provides positive feedback into the hold off circuit for a rapid switch off.

At the end of each sweep, the emitter of TR703 goes positive and this transistion is coupled through D711, R731 and C763 to produce a positive 'spike' at the input to gate IC707c. This inverts the impulse to generate a narrow low going pulse on its output which is distributed as necessary to switch control circuitry in the various Alternate modes. IC707a is normally enabled except in CHOP mode and drives this pulse to inverting gate IC707b, which provides a negative going edge to the Y-amplifier via Pt. 715 to operate the beam switch.

4.4.3 AUTO, SINGLE SWEEP AND X-Y

The timebase modes, AUTO, NORMAL and SINGLE, sweep are selected by the three interlocking switches, S707, S706 and S708 respectively. Whereas in the NORMAL mode no timebase ramp will occur in the absence of trigger; in the AUTO mode the timebase free runs and produces a bright line trace.

When AUTO function is selected by depressing S707, the ground is removed from the Auto Bright Line input at PLS pin 4. This allows the junction between R720 and C705 to follow the control signal from the trigger detector circuit from PLS pin 4. In absence of trigger, D706 is cut off. D707 and D749 have their anodes taken to the +12V rail via R728 and when IC702c output at pin 14 is low, current will flow from R728 to ground via R724. This causes a logic low to appear on the preset input pin 12 of IC701b via diode D707 and R719.

At the end of the hold-off period, pin 14 of IC702c goes high. The current flowing in R728 will then pull the Preset input of IC701b high via D707. The Q output of IC701b is therefore driven high and the ramp sweep restarts without any trigger applied. When a trigger signal occurs, the trigger detector operates. TR518 on the trigger circuit turns on the 'TRIGGER' l.e.d. and also removes current from R728 via D706 and R720. This has the effect of making the preset input of IC701b go low. The timebase will only sweep in this condition when a trigger signal clocks the bistable IC701b.

In the NORMAL mode of operation, the ground provided by S707 prevents the Preset input of IC701b from rising, by returning the current in R728 to ground via D706 and R720.

When the SINGLE SWEEP button S708 is depressed, both S706, the NORMAL switch, and S707, the AUTO switch, are released. This inhibits both normal and auto triggering of the timebase. S708 operates as a spring return action switch without any latch action. Each depression of S708 will cause the timebase to be armed in readiness for a trigger signal, which when given will cause the timebase to make one sweep and then reset.

With S708 in the released position, C701 charges via R701 from the +5V rail. On pressing S708, this charge is applied to the Preset input of IC701a at pin 5, setting the outputs to Q high and $\overline{Q}$ low. The Q output at pin 2 of IC701a is applied to the emitter of TR701. Because the base of this transistor is held at approximately 3.3V by the network D702, R710 and R712, it conducts and passes current to the ARMED l.e.d. via R709 and PLV 12. The low $\overline{Q}$ output at IC701a pin 3 is applied via R703 to pin 4 of OR-gate IC702a. The other input to this gate is applied from the reset line to pin 5 which is normally low except at ramp reset, therefore the output at pin 2 will be low to the clear input of IC701b.

IC701b therefore awaits a trigger pulse to initiate a ramp with the single shot ARMED l.e.d. illuminated. When this occurs and the timebase has completed the ramp, IC701b changes its state to Q low (pin 15) and $\overline{Q}$ high (pin 14) in the normal way to commence the fly-back. This action then clocks a logic low to IC701a since the D input is permanently low on pin 7. The Q output at pin 2 of IC701a then drops low and the ARMED l.e.d. is turned off. IC701b is then held reset by IC701a. $\overline{Q}$ signal at pin 3 via the gate IC702a. The bistable IC701a can then be prepared for another sweep by pressing the 'ARM' button S708 once again. R703 and C775 form a low pass filter to prevent narrow spikes from IC701a resetting IC701b if S708 is pressed during a sweep.

When the timebase is in the AUTO or NORMAL modes, IC701a is held preset by diode D701, thus disabling the single shot function.

It is necessary to inhibit the 'A' ramp generator during the X-Y mode of operation. When the X-Y switch S705 is depressed, +12V is applied to the anode of D705 via R716. This voltage is clamped to +5V by D705 and is applied via R714 and D704 to pin 2 of IC702a. This pin is directly coupled to the Clear input of IC701b, the timebase bistable, and holds this circuit in a permanent reset state.

4.4.4 DUAL TIMEBASE OPERATION

In the 'A Intensified by B', 'B' only and 'A & B Alternate' modes, the B timebase is intiated at a selected point during the A timebase sweep as set by the DELAY control. The B timebase may be initiated in two different ways, the simplest mode being B STARTS AFTER DELAY, which is set by S516 on the B TRIGGER LEVEL control, R612. In this mode, the setting on the DELAY control vernier determines directly the start of the B ramp. The B timebase may also be used in the 'B GATED' mode where the B timebase is merely armed on reaching the DELAY setting and awaits a trigger pulse from the B trigger amplifier before a B sweep commences. The delay period is generated as a portion of the A sweep period to the delay comparator circuit.

The A ramp is fed from the emitter of TR720 to the dual comparator IC710a and IC710b, via R897 and R898 to pins 12 and 5 respectively. The bistable IC705b is only functional if Time or 1/Time measurement is required while the DVM option DM3010 is fitted. Normally this bistable is held preset by a shorting plug on PLU pin 6 holding pin 10 of IC705b at 0V. This allows only the comparator IC710b to function since IC710a strobe is held low on pin 9. The DELAY control R5 on the front panel has exactly 4V set across it by the resistors R916, R917 and preset control R915. R917 has only about 80mV across it to act as a back-off voltage for the DELAY control to allow for various offsets in the comparators and timebase ramp generator.

The voltage at the wiper of R5 is fed to the unity gain buffer IC706 at pin 3. The output at pin 6 is then fed to the inverting input of the comparator IC710b at pin 13. When the timebase ramp has risen to the potential set by the DELAY control, the output of IC701b rises quickly to about +3.0V. R887 is used to provide some positive feedback which allows the comparator to snap over cleanly when the desired level is reached. The output from IC701b pin 1 turns off transistor TR746 by diverting the emitter current in R893 to D745 and R895.

The collector of TR746 is only allowed to rise to +4.4V (ECL LOGIC HIGH) by the action of R890. The components D744, D745, C754, C755, R894 and R895 are relevant only when the DM3010 option is used. They introduce a delay of only a few nanoseconds to compensate for any differences in group delay between the two comparators. Section 4.7 covers the operation with DM3010 in full detail.

If the B STARTS AFTER DELAY condition is selected on the B TRIGGER LEVEL control (R612 and S516), then the input on pin 7 of IC703b is low. IC713d is switched off, providing a high input to gates IC703c and IC703d on pins 11 and 12 respectively. Since gate IC703c is turned on, its output at pin 14 will stay low and cannot pass trigger signals from the B Trigger Amplifier. The output of gate IC703d pin 9 goes high, which is applied to the D input of the B timebase bistable, IC704a, at pin 7. The positive signal edge from the comparator IC710b via TR746 then passes through the two NOR gates IC703a and IC703b to emerge at the IC703b pin 3 and provide a positive edge trigger to clock the bistable IC704a at pin 6. This action initiates the B ramp.

When the B trigger amplifier is to be used in the 'B Gated' mode S516 on the Trigger p.c.b. is closed, applying a high to IC703b pin 7 and at the same time turning on transistor IC713d. This puts a low to the inputs of gates IC703c (pin 11) and IC703d (pin 12). Any trigger pulses from the B Trigger Amplifier will now pass through gate IC703c, becoming inverted as they do so. The output of IC703c pin 14 is fed to the clock input of IC704a pin 6. However, since the D input is low (pin 7) and the bistable IC704a is reset, its state remains unchanged. When the comparator output IC710b rises as the ramp reaches the voltage preset by the DELAY control, the gate IC703d pin 13 is driven high via TR746. This raises the D input of IC704a high and enables the bistable to be clocked upon receipt of a trigger pulse and so start the B ramp generator.

Note that the gate IC703c inverts the trigger pulses and in order for the trigger to have the correct polarity, the +/- TRIGGER SLOPE switch, S505, on the Trigger p.c.b. is wired in a reverse fashion with respect to the A Trigger Amplifier.

4.4.5 B RAMP GENERATOR

The B ramp generation system with its start point stabilisation is very similar to that already described for the A Timebase. It does not include Hold-Off or Auto facilities so the circuit description will only be described briefly in this section, unless it is significantly different. When the bistable IC704a changes state to initiate the B ramp, the Q output goes high (pin 2) and $\overline{Q}$ (pin 3) goes low. These two outputs are directly coupled to the bases of trasistors TR724 and TR725. TR724 is therefore driven on and TR725 off. TR724 is coupled via R801 to the emitter of the flyback transistor TR727. This allows TR724 to draw the emitter current from TR727, thus turning it off. The constant current charging transistor TR738 then charges the timing capacitors C742, C746, C740 and trimmer C741 as selected by transistors IC713a and IC713b under the control of the B Time/cm switch S4. This switch also selects the current defining resistor RT in the constant current generator TR738, TR739 and TR740.

The potential at the timing capacitors is buffered by the source follower TR736 and emitter follower TR735 to provide the B ramp output.

The ramp output from TR735 is applied to pin 7 of OR-gate IC702 via R793 and HF compensation network R792, C735. These components together with R791 determine the switching point of IC702b and ensure it occurs at the 4.4V maximum excursion of the ramp. When this occurs, the output of IC702b goes high and applies this logic level to the Clear input of IC704a at

pin 4. The Q and $\overline{Q}$ logic levels on this bistable are then reversed, switching the conduction states of TR724 and TR725, causing the ramp to reset.

During the waiting period before the B ramp commences, the output from TR735 is held at 0V by the action of TR733 which acts as a sweep start stabilization control. The emitter of TR733 is connected to 0V via the low value resistor R820. When the emitter of TR735 reaches 0V at the end of the flyback period, some of the current through R825 flows in diode D735 and thus turns on TR733. TR733 then controls the current in the flyback current source, TR727, at its emitter such that the voltage at the emitter of TR735 is maintained at 0V. TR734 in the emitter circuit of TR735 functions as a double diode to compensate for the voltage drops across D735 and the base-emitter of TR733. R824, R821 and C749 prevent overshoot on flyback in a similar manner to R756, R757 and C716 in the A ramp generator circuit.

When the timebase bistable IC704a is reset, the $\overline{Q}$ output at pin 3 goes high. This then clocks the single-shot bistable IC704b at pin 11. The $\overline{Q}$ output of IC704b therefore goes high because the D input at pin 10 is connected to ground. The high at $\overline{Q}$ is fed to the Clear input of IC704a at pin 4 and this prevents further triggering of the 'B' bistable.

When the 'A' ramp has completed its sweep, the 'A' timebase bistable IC701b has a logic high at the $\overline{Q}$ output on pin 14. This high is applied to the Preset input of IC704b at pin 12, reverting the $\overline{Q}$ output at pin 14 to a logic low which is applied to the Clear input of IC704a, enabling this bistable to switch again on the next trigger pulse.

If 'A' only is selected, the 'B' timebase must be inhibited. This is accomplished by applying +5V to the anode of D734 when the 'A' only switch (S701) is depressed. This logic high holds the Clear input of IC704a at pin 4 high and therefore inhibits the 'B' bistable.

4.4.6 X MODE SELECTION

The three way analogue switch IC709 is energised as necessary to select the A ramp signal, the B ramp signal or the X-Y signal to drive the X amplifier. Selection of A or B is derived from the state of bistable IC708a and applied to IC709 via transistors IC712b, IC712c.

When A only is selected by S701, D721 conducts via R852. D722 clamps the Clear input of IC708a to 0V. With Q low and $\overline{Q}$ high, IC712c is turned off and IC712b is turned on. IC709b is energised, selecting the 'A' ramp. Similarly when 'A Intensified by B' is selected by S702, 0V is applied directly to the Clear input of IC708a with the same result.

When 'B' Only is selected by S703, 0V is applied directly to the preset of IC708a. Q is high, $\overline{Q}$ is low. IC712c is turned on and IC712b is turned off, enabling IC709c to select the 'B' ramp.

When 'A and B Alternate' is selected by S704, the Preset and Clear inputs to IC708a are both high and this bistable is clocked at the end of each A sweep by the signal from IC707c. In all single trace Y modes, the preset of IC708b is low and the Q output provides a high input to the J and K inputs of IC708a. The latter then switches state at the end of each A sweep, selecting 'A' and 'B' ramp signals on alternate sweeps.

When a multiple trace mode is selected, e.g. ALT or CHOP, the voltage at PLT 19 drops low and TR748 is turned off, removing the Preset from IC708b. This now forms a $\div 4$ circuit with IC708a and the X selection switches are driven to allow two consecutive 'A' sweeps followed by two consecutive 'B' sweeps. Meanwhile the beam switch in the Y amplifier chain is alternating between CH1 and CH2 to provide the required 4 trace display.

When 'A and B Alternate' is selected, trace separation is required. Operation of S704 removes the bias via R874 holding Transistor IC712a on. This is now switched in parallel with IC712b under the control of IC708a to enable IC709a on each 'B' displayed sweep. The bias set by the TRACE SEPARATION control R4 is applied to IC712c to modify the differential output current from the transistor pair IC712c and IC712d. These signals are fed into the Y signal path.

In the X-Y mode S705 is operated. IC709d is enabled directly to select for X deflection the X-Y signal from the A Trigger Amplifier. Current in R853 via D725 and D726 ensures that both the Preset and Clear signals are applied to IC708a. Q and $\overline{Q}$ are both high, inhibiting both the 'A' and 'B' signals.

4.5 X OUTPUT AMPLIFIER

The ramp input from the timebase via IC709 is applied to the commoned base connections of TR810 and TR812 via R929. These transistors, with TR809 and TR811 form two long-tailed pairs. Transistors TR810/TR809 forming one, TR812/TR811 forming the other.

The opposite commoned base connection of TR811 and TR809 is fed with the X shift voltage from the emitter follower TR815 via R979. The base of the emitter follower is connected to R965 which forms a potential divider with R967 and R966 operated by the COARSE and FINE shift controls. Long-tailed pair TR810/TR809 has a 'tail' circuit comprising R962, R963, R961 and 'Set X1 gain' pre-set potentiometer R960. The 'tail' circuit of TR812/TR811 comprises R959, R958, R956 and 'Set X10' pre-set potentiometer R957. Resistor R928 and C831 across these last two resistors provide HF peaking.

The Long-tailed pair TR812/TR811 have the 'tail' current provided by the constant current source, TR813. The voltage at the base of this transistor is derived from the +24V rail by the potential divider R968 and R970. TR813 emitter is connected to the anodes of

D812 and D813 via R969 and 'adjust on test' component R971 in parallel with it. The cathode of D812 is taken to -12V when S705, the X-Y mode switch, is operated. Similarly, the cathode of D813 is returned to the same potential when the X10 MAGNIFICATION switch is operated. When either diode is taken to -12V the emitter of TR813 can draw current, enabling the long-tailed pair TR812/TR811 and so selecting the X10 amplifier.

A connection is also made from the anodes of D812 and D813 to the base of TR814 which supplies the 'tail' current for the other long-tailed pair TR810/TR809. A negative voltage applied at the base of TR814 will cut this transistor off and the associated long-taile pair TR810/TR809 will be inhibited. In the absence of the negative bias, TR814 is held in conduction by the potential divider R974, R975 and R976 to the +24V rail. Hence, applying -12V via either D812 or D813 enables the long-tailed pair TR811/TR812 to give X10 X expansion or allowing D812/D813 to float enables TR809/TR810 to give X1 X gain. TR806 and TR808 operate as emitter follower buffers to the common emitter stage TR805 and TR807 respectively. The remaining part of the X amplifier now operates as two independent shunt feedback amplifiers, each driving an X plate. TR803 forms a cascode stage with TR805 as also does TR804 with TR807. The collector loads of TR803 and TR804 are the constant current sources TR801 and TR802. Shunt feedback in the amplifier section TR801, TR803, TR805, TR806 is applied via R938 together with the capacitor 'T' network C814, C818 and trimmer C816 applying HF compensation. This capacitor network operates in a way equivalent to the effect of a very low capacitance variable trimmer across R938. A similar feedback network, R944, C813, C815, C817 exists in the other amplifier half TR802, TR804, TR807 and TR808. The two amplifier halves differ in that TR805/TR806 and TR807/TR808 are PNP/NPN and NPN/PNP respectively. This enables the transistors TR805 and TR807 to provide maximum current drive to the output stages during the ramp period. Accordingly, therefore, the stage TR801/TR803 produces a positive going ramp signal at the commoned collector point, whereas that on the stage TR803/TR804 is negative going. The constant current sources TR801 and TR802 are provided with HF current boost via C807/C808 and C805/C806 respectively. This current drive is provided from TR805 and TR807 and the charge on the capacitors is recovered during the return transient via resistors R930/R941 and R931 respectively.

Components C821, R939, C810, L702 and C820, R943, C811, L701 are used to provide HF stability to each amplifier circuit. The current sources TR801 and TR802 are provided with bias voltage derived from the zener D801 and the bleed resistor R937, with C802 and C822 used for decoupling. This resistor is also used to provide current for the zener D802 which biases TR803. Output to the X plates is fed via R988 and R989 with zener diodes D815 and D816 used to drop the X plate voltage to the mean plate potential.

The commoned emitters of TR805 and TR807 are held at the fixed potential of +7.5V provided by D803, C829 and R946. Hence the voltages at the bases of TR806 and TR808 are also fixed at this value and are virtual earth points. Current drive to these virtual earth points from the common emitter amplifiers TR809 - TR812 described previously is fed via the diodes D806 and D807. Diodes D806–D811 are used in a current limiter circuit to prevent the output transistor TR801 and TR802 from saturating. The operation is best described by considering the case when TR812 is fully on and TR811 fully turned off. This would be the case when the timebase ramp is almost complete and an expanded trace has shifted well off to the right of the c.r.t. screen. TR812 emitter therefore takes all the current provided by the constant current source TR813. The current from the collector which normally flows through D806 to the base of TR806 would be sufficient to turn TR806 off and cause TR801 to saturate. However, because TR811 is not conducting the potential across R955 turns off D807, and the excess current from R955 bleeds through D810 and D811 to the collector of TR810. This prevents TR806 from being turned off and so limits the voltage at the junction of TR801 and TR803 from exceeding 100V. At the same time the voltage at the junction of TR802 and TR804 will be low, and since D807 is turned off, TR804 is prevented from saturating by the action of the current bleed through R951. TR804 normally limits at about +25V. A similar limiter circuit for the other amplifier half exists using D806, D808 and D809 which becomes effective prior to the start of trace on the left hand side of the c.r.t. display.

The TRACE LOCATE is achieved by the circuit R948, R949, D804 and D805. Normally D804 and D805 are reverse biased, with the result that no current flows in R948 and R949. When the TRACE LOCATE button is pressed +12V is applied to D804 and D805. This causes current to flow in R948 and R949 and divert some of the current from flowing in the virtual earth points at the bases of TR806 and TR808. As a result, TR806 and TR808 run out of drive current while the trace is still on the screen and the trace limits prematurely.

4.6 POWER SUPPLIES

The a.c. supply is applied to the primary windings of transformer T1 via the voltage selection switches S15 and S16, fuse FS1 and POWER switch S1. S15 connects the primary windings in series or in parallel, while S16 introduces an additional 20V tap as required. Multiple secondary windings provide low voltage a.c. inputs to the d.c. supply generation circuits. Secondary windings are also provided to supply 6.3V r.m.s. a.c. for the heaters of the c.r.t. and an a.c. input to the Trigger Amplifier circuit for use as described in Section 4.3.1.

4.6.1 LOW VOLTAGE SUPPLIES

+5V D.C. SUPPLY

This supply is derived from the output of bridge rectifier BR1002 supplied from T1. An additional a.c. output is also taken from this winding to supply the 'External DVM' facility (SKQ).

The +9V unregulated output from BR1002 is applied to the voltage regulating integrated circuit IC1003 after smoothing by C1025. The voltage output from the regulator is determined by the ratio of R1049 and R1050. This ratio is such that 5V is obtained at the output. C1026 provides additional smoothing and de-coupling and diode D1023 protects the regulator IC in the event of the +5V output shorting to a negative rail. Fine adjustments of the output voltage of this supply can be made by selection of the Adjust on Test (A.O.T.) resistor, R1058.

−12V D.C. SUPPLY

A further secondary winding of T1 supplies the bridge rectifier formed by D5, D6, D7 and D8. The d.c. output from this bridge is applied to the reservoir capacitor C3 and the voltage regulator IC1002. The ratio of resistances of R1047 to R1048 is adjustable by potentiometer R1052 which is set to give 12V at the output of the regulator. This output is smoothed by C1023 and the positive side is connected to OV. As a result, the un-grounded end of C1023 is therefore at −12V and this point forms the supply rail. Diode D1022 protects IC1002 in the event of the −12V output shorting to a positive supply rail.

The same secondary winding drives D9 and D10 which with D5 and D8 form a further bridge rectifier to generate an unsmoothed full wave rectified supply to drive the graticule illumination lamps. The actual voltage applied to the lamps is controlled by the potentiometer R435 and the emitter follower TR405.

+12V SUPPLY

Diodes D1, D2, D3 and D4 form a bridge rectifier for this circuit. Smoothing is provided by C2 and 18V is thus provided for voltage regulator IC1001. The output voltage is adjusted by R1051 to give +12V. The circuit action is identical to that described for the −12V supply but in this case the negative side of the stabilised supply is grounded.

+60V, +120V AND −120V SUPPLIES

These supplies are derived from a single secondary winding, one end of which feeds a half wave rectifier D1018, giving the 60 volt output, and a voltage doubler circuit, C1021, D1011, D1010, C1019, giving the 120V output. This end of the winding is made to swing ±60V about ground by the action of the bridge rectifier and C1017 connected between the low voltage end of the winding and ground. This allows the low voltage end to swing about by ±V where V is the voltage on C1017. Since the secondary winding supplies current to the 60V and 120V loads, this tends to charge C1017 via BR1001. The voltage across C1017 is adjusted to maintain a constant 60V output by the conduction of TR1006. When the low voltage end of the secondary winding swings negative, diode (a) in BR1001 is turned on, and the base of TR1006 is at its most negative value (approx −1.5V).

The base of TR1006 is driven by diode D1013 and emitter follower TR1007. This transistor is biased between the +60V and −12V supplies such that its base will be at about 0V when the +60V supply is at the correct voltage. If the +60V supply is high, then the cathode of D1013 will tend to remove excess charge from C1016 on negative transients of the base of TR1006, thus reducing the conduction in TR1006 and allowing the voltage across C1017 to rise. This reduces the swing at the high voltage end of the secondary. If the 60V is low, D1013 will not conduct strongly hence R1042 will force more current into the base of TR1006 to increase conduction and so drop the voltage across C1017, consequently the 60V output will be made to rise. As a result of regulating the +60V supply, the doubled 120V supply will also be partially stabilised. A further −120V supply for the X output amplifier is provided by the doubler circuit C1029, C1030, D1028 and D1029.

+24V SUPPLY

This consists of a 12V regulator IC1004, with its low terminal connected into the +12V rail. Feedback input at the junction of R1031, R1029 is compared with the references (generated internally at pin 4) applied to pin 3. The supply voltage for this regulator is derived from the +75V line by R1027 and the 18V zener D1008 connected to the +12V line. The +24V output from IC1004 at pins 1, 6 and 10 is fed via PLD pin 4 to the timebase circuit. C1006 provides output decoupling and D1012 protects IC1004 against a short circuit to ground by loading down the +12V line.

4.6.2 E.H.T. SUPPLIES

The e.h.t. supplies for the grid, cathode and p.d.a. of the c.r.t. are supplied by a high frequency oscillator or inverter driven from the +12V and −12V supplies. Transformer T1101 is the e.h.t. oscillator transformer driven by transistor TR1103 biased to class C through the feed back winding 4 and 5 at a natural oscillating frequency of approximately 30kHz. Regulation of the −2.2kV supply is provided by a feedback control loop formed by TR1102, TR1101. The amount of drive and thus the magnitude of the e.h.t. output voltage, is determined by the base drive of TR1103 which flows through the feedback winding 4 and 5 of transformer T1101. As point 4 goes positive, increasing the conduction of TR1103, point 5 goes negative and C1105 charges negatively via D1105 and R1112. As a result, the next pulse of output current from TR1103 will be less than the preceeding one and the e.h.t. output will also be smaller unless the charge in C1105 is restored.

The average charge on C1105 is controlled by the collector current of TR1102. If this current is sufficient then C1105 will not discharge, the required current being provided by the transistor. Transistor TR1102 is controlled by an error amplifier formed by TR1101. The reference voltage for this amplifier is derived from the +12V rail via R1105, R1106, R1103 and the error voltage is applied from the 2.2kV output via R1125 to the base of TR1101. The action of the circuit is such that a current balance is achieved at this base.

If the -2.2kV output at the c.r.t. cathode becomes less negative, TR1101 conducts more, increasing the base drive to TR1102 and increasing the current in the output transistor, TR1103, due to C1105 being charged positively. If the -2.2kV output becomes more negative, i.e. the voltage is too high, then TR1101 conduction is reduced. This in turn reduces the drive to TR1102 which allows the charge on C1105 to go negative and thus reduce the output voltage.

Diode D1103 in the emitter of TR1101 is always conducting and provides temperature compensation for this transistor, with the emitter current provided by R1114. Diodes D1101 and D1102 at the base of TR1101 protect the base-emitter junction. Preset resistor R1106 functions as the 'Set e.h.t. control'.

Resistors R1101, R1102 and diode D1104, in conjunction with the choke L1101, form a current limiting circuit. Under normal operating conditions, the current through L1101 is approximately 250 - 300mA. If this should increase beyond this value, the voltage drop across L1101 will cause the decoupled +12V supply at the emitter of TR1102 to reduce to the point where D1104 becomes forward biased by virtue of the voltage across the potential divider R1101 and R1102. This diode then shorts out the error amplifier circuit and breaks the feedback loop so causing an effective current limit.

The secondary of the e.h.t. transformer T1101 drives two separate voltage multiplier circuits. The first circuit is fed from point 8 on the transformer and comprises a voltage doubler formed by C1114, D1111, D1112 and C1115. The resultant output voltage at the junction of R1123 and C1115 is 2.3kV which is smoothed by C1116 after being dropped to 2.2kV by 100V Zener diode D1114. This is the point fed back as the error voltage to TR1101 and is fed via R1120 to the cathode of the c.r.t. holding this at a fixed potential.

R1126 normally holds D1115 on and provides the ground return current for this voltage doubler via the cathode of D1111. This point is decoupled by C1117. If the cathode current drawn by the c.r.t. should become excessive (e.g. at very high Intensity settings) then the return current through D1111 will be greater than that provided by R1126. Hence, TR1105 will by turned on which effectively drives the c.r.t. grid more negative and limits the current in the tube.

An additional voltage doubler circuit C1109, D1107, D1108 and C1111 is driven from the same tap, pin 8, of the transformer but its output is referred at D1107 not to 0V but to the output potential of the bright-up amplifier, driven via emitter follower TR1104. If the emitter of TR1104 is near 0V, the voltage doubled supply, used to drive the grid of the c.r.t. would be at -2.3kV. That is the same as the output from D1112, and so more negative than the cathode by approximately 100V, the voltage across D1114. Thus the c.r.t. will be cut off. The grid is actually fed from R1119, which allows its potential with respect to the cathode to be adjusted to the point of cut off. As the output of Bright-up amplifier, described in Section 4.6.4. goes positive, the grid supply from D1108 will follow and the d.c. level fed to the grid via R1118 and R1039 will rise accordingly. The fast a.c. transition from the blanking amplifier is fed via C1015 and R1021 to the grid. As this electrode moves positively with respect to the cathode the beam of the c.r.t. is turned on. The third output from the e.h.t. oscillator is taken from pin 10 of the high voltage secondary winding and applied to X6 multiplier module to generate +14.3kV which is applied to the p.d.a. mesh of the c.r.t.

4.6.3. TUBE CONTROLS

A potential divider chain R1124, R438 and R433 is connected from the -2.2kV cathode supply to 0V. R438 is the FOCUS control and the wiper of this potentiometer is connected to that electrode. The geometry or I.P.S. electrode is taken to the wiper of a potentiometer, R440, with a control range of +100V to -12V. R447 also provides the 120V HT supply to the astigmatism control R439 which drives A3 of the c.r.t. This electrode potential is settable from +100V to +45V.

The heater of the c.r.t. is supplied directly from its own winding on the supply transformer but its mean d.c. potential is held at the cathode potential by R6.

Minor misalignment of the deflection plates can prevent the trace from aligning with the graticule lines and a correction or trace rotation coil is fitted. Current through this is set by R436 and driven via emitter follower TR406 from the +12V and -12V supply lines. The present of D402 allows the correction current to be adjusted through zero but the connections to the coil must be reversed if a large correction current is required.

4.6.4. BRIGHT-UP AMPLIFIER

The function of the bright-up system is to turn the trace on to the level set by the INTENSITY control during each normal sweep and on continuously in X-Y mode. in the 'A Intensified by B' mode, additional bright-up is applied during B portion of the A sweep. The system is based on a shunt-feedback amplifier and responds to the algebraic sum of signals derived from the INTENSITY control, the A Timebase Bistable, the B Timebase Bistable and external Z mod. input. An

over-riding blanking input can be applied from the Chop Oscillator.

The amplifier is formed by TR1002 and TR1003, with shunt feedback via R1019 from the collector output of TR1003 to the virtual earth at the base of TR1002. TR1005 cascode connected with TR1004 provides a constant current load for TR1003 with additional high frequency drive to the output via C1004.

In the blanked condition D1004 is reverse biased and R1016 and R1018 determine the output level at approximately +5V. Subsequently, current applied via D1004 will drive the output voltage positive. Full bright-up occurs with approximately 2mA in D1004 and the output at approximately +55V. When blanked, the current from the collector of TR1001 is 4mA. 2mA is drawn through R1014 leaving 2mA in D1003. This exceeds any current via R1013 from the INTENSITY control R437.

In the normal 'A' sweep, -2mA is drawn through R1002, reducing the collector current in TR1001 to 2mA. With no current in D1003, the current in D1004 is controlled by R437, i.e. the bright-up is controlled by INTENSITY as set. This condition applies also in the X-Y mode and during the A or B sweeps of 'A and B Alternate' and 'B' only modes.

In the 'A Intensified by B' mode, the current in R1002 is less than 2mA during the A sweep, increasing to 2mA or more during the B sweep. The amount by which this current is less than 2mA is determined by the preset Contrast control R850. Thus, the resultant bright-up is determined both by the Contrast and Intensity settings.

In the Chop mode of operation, a positive drive is applied to pin 1014 during each Chop transition. Current through R1011 is applied via D1006 to exceed any current in D1004, blanking the trace as required.

A positive voltage applied to the Ext. Z mod. input will drive current via R1001 and D1001 to provide blanking.

The control currents via R1002 are derived from the timebase circuit as the summed currents from R861, R860, R859 and the collector of TR750.

In 'A' only, with S701 operated, 2mA flows through R851 and D729 into the emitter of TR749. Since the bistable IC708a is in the Cleared state for this mode, TR750 is biased into conduction by the high $\overline{Q}$ output. The 2mA current from TR749 collector flows through this transistor and balances an equal and opposite current provided by R861. Before the A Timebase commences to sweep, the voltage at the emitter of TR703 is the same as that at the virtual earth blanking input Pt. 708 (i.e. 3V) and no current flows through R860. Also, no current flows through R859 from the B Timebase. As a result, no current drive is applied to Pt. 708. When the A ramp starts the emitter of TR703 drops to approximately 0V and a -2mA current flows through R860 which enables the Bright-up amplifier.

In the 'B' only mode, with S703 operated, there is no current in TR749 and hence none in TR750. Before the start of the A sweep, R861 defines +2mA into Pt. 708. When the A sweep starts, this is offset by the current in R860 with no resultant bright-up. Only When the B sweep is running also does R859 introduce a further -2mA to cause bright-up.

In the 'A Intensified by B' mode, with S702 operated, R851 and the Contrast control R850 defines a current between approximately 0.7mA and 2mA into the emitter of TR749 and hence through TR750. Thus, during the A sweep the output current is between -0.6mA and -2mA (partial bright-up). When the B ramp is running also R859 introduces a further -2mA for full bright-up.

In the 'A and B Alternate' modes, with S704 selected, D730 energises the contrast path R850 and R851.

During the A display sweep, the circuit operates as for 'A Intensified by B'. During the B display sweep the $\overline{Q}$ of IC708a will be low, turning off TR750. The current from TR749 flows through D723 but the output currents are as for 'B' only.

In X-Y, selected by S705, the A and B timebase signals are inhibited and R854 draws 4mA via D728, TR749 and TR750 for a resultant output of -2mA for a steady bright-up.

4.6.5 CALIBRATOR

This circuit provides a readily accessible calibration source for the 'Y' amplifier. Its output is provided at the front panel. The circuit consists of an operational amplifier IC714, connected as a relaxation oscillator with R983 and C844 forming the feedback timing elements. The output voltage swing of IC714 gates a current, derived from the +12V line via R985, into the output resistors R987 and the close tolerance component R699. When the output of IC714 is low, diode D822 is biased on by the positive supply line and current flows into the op-amp output. When the amplifier output is high, D822 is biased off and D821 conducts, passing current into the output calibration resistors. C845 limits the maximum slew rate of the output edges. The output available for calibration purposes is 1.0V or 1mA into a shorting link between the output pin and earth connector.

4.7 OPERATION WITH DM3010

This section covers the control circuitry of the OS3600 which operates specifically with the DM3010. The full circuit description of the DM3010 is included in the handbook for that unit and reference should be made to that also for a full understanding of the complete system.

4.7.1 TIME AND 1/TIME MEASUREMENT

In this mode of operation, the timebase system has to generate B sweeps at two positions on the A sweep. The first occurs at the time set by the normal DELAY control of the OS3600. The second is delayed with respect to the first by a period set by the v/t control of the DM3010. This section should be read in conjunction with Section 4.4.4 and 4.4.5 describing the independent operation of the dual timebase system.

At the end of each A sweep, the emitter of TR703 goes positive and this transition is coupled through D711, R731 and C763 to produce a positive 'spike' at the input to IC707c. This gate inverts the impulse to apply a clock signal to bistable IC705b. This bistable is normally held in the preset state with 0V applied to PLU pin 6. This is applied via a shorting link on PLU if a DM3010 is not fitted and via switch contacts of DM3010 if fitted. When Time or 1/Time modes are selected by DM3010, this link is broken and IC705b is free to switch state at the end of each A ramp. The Q and $\overline{Q}$ outputs thus enable either comparator IC710a or comparator IC710b on alternate A sweeps. IC710a follows the normal DELAY setting while IC710b follows the additional delay level from the DM3010 via PLU pin 5. (See Section 4.1.7).

When the Y display mode 'CH1 and CH2 Alternate' mode is selected, R906 is connected to 0V by S712, and TR747 is free to switch under control of the signal from the beam switch bistable via PLT pin 9. The collector output of TR747 is applied to the J input of IC705b. Both bistables are clocked at the end of the A sweep and this link keeps them in step so that the normal Delayed B sweep is applied to CH1 displaying sweeps and the additionally delayed B sweep to CH2.

When Time Measurement and Trigger View modes are selected together with either CH1, CH2 or ADD, a similar situation exists as would be the case is 'CH1 and CH2 Alternate' were selected. The trace order is locked by TR747 and displays the 1st time delay on Trigger View and the second time delay on either Y channel.

Note that when 'CHOP' is selected for this combination both 1st Delay and 2nd Delay are displayed with each Y channel.

4.7.2 VOLTAGE MEASUREMENT

The generation of the additional Y shift signal which is applied to the CH1 channel when the DM3010 is set to Voltage measurement via the OS3600 is described in Section 4.2. Control of this offset switching is derived from IC705a.

This bistable is normally inhibited from responding to 'end of A sweep' clock signals by a high applied to its preset input via PLU pin 7. This is maintained by a shorting link when no DM3010 is fitted and via the relevent switch on the DM3010 if fitted. However, when this contact is broken, IC705a is free to respond to its clock inputs and its Q and $\overline{Q}$ output levels reverse state on alternate A sweeps, controlling the Y shift generator of CH1 via PLT pins 1 and 3.

The Q output of this bistable also controls gate IC707a to inhibit every other 'alternate' switching signal to the Y channel beam switch. Thus, when 'CH1 and CH2 Alternate' mode of Y display and DM3010 voltage measurement are selected, the sweep sequence will be CH1, CH2/normal shift, CH1/additional shift, presenting a 3 trace display.

The simultaneous application of 'A and B Alternate' timebase mode with DM3010 voltage measurement is inhibited. Warning of this prohibited combination is given as the relevant l.e.d. on the DM3010 is energised from the -12V supply via S704 and R911. This same signal line applies preset to IC705a to inhibit the voltage measurement sequence. A similar inhibit is applied to IC705a via S705, R841 and D754 when X-Y display mode is selected and voltage measurement does not apply.

When CH1, CH2 and Trigger View are in Alternate trace mode, the Y beam switch IC306a and IC306b divides by 3. The 'J' line to pin 11 of IC705b is then driven high when CH1 and Trigger View are selected, thus the 1st Time Delay is displayed on these channels and the 2nd Time Delay on CH2.

The trace order is as follows:–

CH1/1st Time Delay
Trig View/1st Time Delay
CH2/2nd Time Delay

If 'CHOP' mode is selected, TR747 is not switched into circuit with the result that both Time Delay positions are shown for each Y Channel and Trigger View.

When 'A & B Alternate' is selected for any single trace Y mode without Time measurement selected, transistor TR748 is turned on by the single trace detect signal from PLT 19. However, the selection of Time Measurement reverse biases the emitter of TR748 and this allows the IC708a and IC708b combination to divide by four. The sweep order is thus – A, A, B, B, A, A, B, B etc. It should be noted that the display selection bistables IC708a and IC708b and the Y beam switch bistables IC306a and IC306b are not synchronised, but display all the required traces by virtue of different division ratios which exist between them. The most complex mode is when 'CH1', 'CH2', 'TRIGGER VIEW' and 'A & B ALT' are selected. Twelve A sweeps are required to complete the cycle, and each trace combination is displayed twice within the cycle. The trace order is shown in the following table:–

No. of A Sweeps	Y Mode	Sweep Selected	Delay Selected (1st or 2nd = D1 or D2)
1	CH1	A	D1
2	TV	A	D1
3	CH2	B	D2
4	CH1	B	D1
5	TV	A	D1
6	CH2	A	D2
7	CH1	B	D1
8	TV	B	D1
9	CH2	A	D2
10	CH1	A	D1
11	TV	B	D1
12	CH2	B	D2

5.1 GENERAL

The instrument is protected electrically by 2 fuses:

1. FS1, mounted in a holder on the rear panel, is in the line of the incoming supply. This is a 20 x 5mm slow blow type. 500mA rating (part number 33685) is required for the 220/240V ranges or 1A rating (part number 34790) for the 100/120V ranges.
2. FS1001, mounted on the track side of the power supply p.c.b. behind the moulded plastic cover on the rear panel is a 20 x 5mm slow blow type, 500mA rating (part number 33685). BEWARE – HIGH VOLTAGES ARE PRESENT ON THIS P.C.B.

The following sections give information on obtaining access to all internal controls and removal of the various printed circuit boards and assemblies as may be found necessary during servicing.

If, during servicing, a component needs replacing, it is recommended that it is carefully desoldered, using either a vacuum desoldering pump or desolder braid, taking care not to damage either the delicate copper track of the printed circuit boards or adjacent components. It will often assist removal of the leads if the component is first cut away leaving as much of the leads as possible connected to the p.c.b. The practice of attempting to solder a new component onto the remaining leads of the old one is not recommended as it is likely to cause poor mechanical and electrical joints.

If a fault cannot be cleared it is recommended that the instrument is returned to the manufacturer for repair. When faults have been cleared, it is advisable for at least those parts that have been repaired to be recalibrated to ensure that the instrument conforms to specification. Note that all knobs are collet fixing. They are removed by prising out the central cap slackening the fixing screw or nut and withdrawing the knob from the shaft.

5.2 ACCESS

Immediate access is available to nearly all preset controls once the top and bottom covers have been removed.

Figures 13, 14 and 15 illustrate various views of the instrument showing the position and function of the preset controls and the major sub-assemblies of the instrument. Each cover is retained in position by four latch fasteners. Each fastener is released by turning it a quarter of a turn anticlockwise. In the locked position the arrow head on the fastener points towards the adjacent frame.

> WARNING: the instrument should be disconnected from the supply while the covers are being removed. Dangerous high voltages are then accessible and the instrument should be operated only by qualified personnel.

The following description details the method for removing the individual assemblies.

5.2.1 Y PREAMPLIFIER AND PREAMP TRIGGER ASSEMBLY

1. Remove the knobs from the Y attenuator switches and Y shift controls.
2. Remove the two nuts holding the attenuator switches to the front panel.
3. Unclip the delay line cable from its fixings around the tube shield and check the cable routing to ensure there is sufficient slack available to withdraw the preamplifier.

   WARNING: Do not stress the delay line terminations as the wire is very fragile. If a DM3010 option is fitted, it will be necessary to at least partially remove it (see Section 5.2 of the DM 3010 Handbook).
4. Remove the 2 screws and wavy washers, fixing the preamplifier to the pillars screwed to the L.H. sidebar, slacken the screw fixing the front pillar to the sidebar and move the pillar rearwards. Remove the three screws and wavy washers securing the preamplifier to the small blocks screwed to the timebase board.
5. Unplug the multiway connector from PLM at the timebase end (SKT). Unplug the Trigger View input lead (SKN) and the "UNCAL" l.e.d.'s (SKNN and SKPP). Unclip the socket (SKLL) at the end of the cable from the CH1 attenuator switch from its parking clip adjacent to the c.r.t. side contact pins or from PLA on the DM3010 option (if fitted).
6. Carefully withdraw the preamplifier outwards and backwards (taking care not to foul the assembly on any fixings or to strain the delay line terminations) as far as the delay line and coaxial leads will allow.
7. To remove the preamplifier completely carefully unsolder the delay line terminations and mark the connections to assist replacement. Ease the line out of the p.c.b. Unsolder and remove the coaxial cables, again mark them to assist replacement. Remove the preamplifier assembly.

5.2.2 Y OUTPUT DRIVER ASSEMBLY

1. Remove the DM3010 option if fitted (see DM3010 Handbook, Section 5.2).
2. Remove the knobs from the INTENSITY FOCUS AND SCALE controls.
3. Remove sockets SKG, SKH, SKJ, SKK and SKL from the plugs on the p.c.b. Note that SKK is reversible so its position should be marked to facilitate reassembly.
4. Unsolder the red and orange wires from pins 408 and 410 and unplug the pink wire from the c.r.t.
5. Desolder the earth braid from the c.r.t. shield to the Y driver p.c.b. It is important that all earth connections are made in the same places on reassembly.

6. Unsolder the two 10Ω resistors, R36 and R37, from pins 405 and 409.
7. Unclip the delay line from the top of the c.r.t. shield and manoeuvre it carefully to enable the p.c.b. to be withdrawn. If the p.c.b. has to be removed completely, carefully unsolder the delay line terminations and ease the delay line out of the p.c.b. Mark the terminations to assist replacement.

   WARNING: Do not stress the delay line terminations as the wire is very fragile.
8. Remove the L.H. sidebar trim by inserting a screwdriver in the slot near the front panel and carefully prising the trim away from the sidebar. Remove the screw and wavy washer under the trim securing the p.c.b. fixing stud.
9. Remove the remaining 3 screws and washers securing the p.c.b. and carefully withdraw the assembly.

   WARNING: Do not operate the instrument with SKK removed. The centre conductor is used to earth the external conducting coating of the c.r.t.

5.2.3 Y OUTPUT MODULE P.C.B. ASSEMBLY

1. Unsolder the red and orange wires at the Y driver p.c.b. end from the pins 408 and 410.
2. Unsolder the 2 10Ω resistors, R36 and R37, at the Y driver p.c.b. end from pins 405 and 407.
3. Disconnect the Y output stopper resistors R38 and R39 from the c.r.t.
4. Remove the screw and washer securing the bracket from the output module p.c.b. to the driver p.c.b.
5. Carefully prise out the rear left hand sidebar trim and remove the two screws securing the output assembly to the sidebar. Carefully ease out the assembly. To remove th output module IC471, first desolder the 7 pins and then remove the 2 screws securing the IC to the heatsink. Note that heatsink compound must be used between mating surfaces.

5.2.4 TRIGGER UNIT

1. Remove the knobs from the A Level, B Level and A Hold Off controls.
2. Unsolder the 27Ω resistors, R23 and R24, from pins 610 and 612.
3. Remove the screw and washer securing the small screen to the rear L.H. corner of the trigger source p.c.b.
4. Remove the two screws and washers securing the trigger amplifier p.c.b. to the connecting pillars mounted on the timebase p.c.b.
5. Remove the two screws securing the fixing brackets to the RH sidebar (Note that the captive nuts will slide along the channel and will need to be repositioned on re-assembly).
6. Remove the sockets SKP and SKR and unscrew the "p" clip from the timebase p.c.b. which retains the coaxial cables.
7. Slide the assembly rearwards to clear the potentiometer shafts and switch buttons. Tilt the front of the assembly downwards and withdraw to the extent allowed by the coaxial leads. To remove the unit completely, unsolder and remove all the coaxial leads, noting their positions for reassembly.

   WARNING: The push button switches are easily damaged by a hot soldering iron. Take great care not to overheat any of the switch pins and resolder to the top of the pin not down at the switch body.

5.2.5 EXTERNAL X ATTENUATOR P.C.B. ASSEMBLY

1. Desolder coaxial lead and R15 (1.1kΩ) from the 1V Cal pin. Remove the coaxial lead screen from its fixing ring.
2. Desolder the 22Ω resistors, R25 and R26, from the Ext. A and Ext. B input sockets.
3. Desolder the 27Ω resistors, R23 and R24, from pins 610 and 612 on the trigger source p.c.b.
4. Remove the two screws (with washer and solder tag with R15 attached) securing the p.c.b.
5. Withdraw the p.c.b.

5.2.6. TIMEBASE UNIT

1. Remove the d.v.m. option if fitted.
2. Remove the trigger assembly as in 5.2.5 above.
3. Desolder the following 5 coaxial leads: The 1V cal signal lead from pins 712, 711; the A ramp output lead from pins 719, 720; the B gate output lead from pins 717, 718; the bright-up lead from pins 708, 707 and the alternate pulse lead from pins 715, 716. Mark to ease replacement.
4. Unplug SKT, SKW, SKV and SKX.
5. Unscrew the solder tag from the chassis to the rear of p.c.b. near the X plate leads.
6. Remove the two X output connectors from the c.r.t. Note that the yellow lead goes to the nearest of the two c.r.t. pins to the p.c.b.
7. Remove the 3 remaining screws (with 3 washers and one p clip) securing the top of the p.c.b. to the support rail.
8. Slide the p.c.b. rearwards to clear the push button switches, downwards at the rear end and then out through the bottom of the instrument, taking care not to catch the X output transistors on the transformer.

5.2.7 E.H.T. P.C.B. ASSEMBLY

WARNING: Beware high voltages.

1. Remove the top screen of the unit by unscrewing the three retaining screws.
2. To prevent e.h.t. flashover to the Y preamplifier, place a suitable piece of insulating material between the rear of the preamplifier p.c.b. and the e.h.t. assembly.
3. Remove the e.h.t. socket from the voltage multiplier, MPR1, with a pair of *well insulated* pliers and earth the c.r.t. final anode lead to chassis via a high voltage resistor of 1–50MΩ. Do not short the final anode directly to chassis. Do ensure that SKK is securely in place before discharging the final anode (Pin 2 of SKK is the ground connection for the external conducting coating of the c.r.t.). When the final anode has been discharged connect it to pin 2 of SKK to prevent it recharging due to energy stored within the glass of the c.r.t.
4. Discharge the h.v. output of MPR1 to chassis via a h.v. resistor of 1–50MΩ. Do not short directly to chassis.
5. Remove SKE from the e.h.t. p.c.b.
6. Unsolder the c.r.t. final anode screen and multiplier ground lead from pin 1101 and the multiplier input lead from pin 1102. Remove four screws and washers and lift out the e.h.t. p.c.b. assembly.

5.2.8 POWER SUPPLY ASSEMBLY

Access to the rear of the power supply p.c.b. is obtained by removing the brown plastic moulding at the rear of the instrument which is held by four screws and washers.

WARNING: High Voltages are present on this p.c.b.

The main power supply is a removable assembly forming the rear of the instrument. Removal of the power supply p.c.b. is most easily accomplished after removing the complete assembly from the instrument.

1. Unsolder the coaxial leads from the A RAMP and B GATE BNC sockets on the rear panel, the 0.5V a.c. trigger winding on the supply transformer, pins 1013/1015 and 1014/1016 on the p.c.b. Mark to assist replacement.
2. Remove sockets SKA,SKB, SKC and SKD from the p.c.b. and the c.r.t. base SKA.
3. Pull the actuating rod off the POWER ON switch and withdraw it rearwards through the front panel. Take care not to damage the switch when the rear panel assembly is removed as it is then in a vulnerable position.
4. Remove the four screws and washers from the inside rear of the instrument which are nearest the corners, releasing the rear mounting feet.
5. Remove the four screws and washers securing the brown plastic moulding covering the rear of the p.c.b.
6. Remove the four countersunk screws fixing the real panel to the side frames and the two countersunk screws securing the top bar. Withdraw the unit.

5.2.9 CATHODE RAY TUBE

1. Remove the e.h.t. oscillator top screen, remove the final anode socket from the top of the multiplier MPR1 and discharge the final anode and multiplier as detailed in section 5.2.7.

   WARNING: Beware high voltages, observe precautions detailed in Section 5.2.7.
2. Unsolder the earth lead for the final anode and screen from pin 1101.
3. Unclip the delay line from the two mounting clips on the top of the c.r.t. shield.
4. Remove the brown plastic rear moulding.
5. Remove the c.r.t. base and the side contact connectors (mark to assist replacement).
6. Unsolder the earthing braid connections between the c.r.t. shield and the Y driver p.c.b. Note the positions for reassembly. This is important.
7. Unclip the graticule from the front panel.
8. Remove the trace rotation socket SKK. Ensure that the final anode (e.h.t.) lead is still connected to pin 2 of SKK (see Section 5.2.7).
9. Remove the two screws securing the rear of c.r.t. shield to the e.h.t. assembly mounting bracket.
10. Slide the c.r.t. and shield rearwards sufficiently to clear the support moulding at the front of the instrument and lift out.
11. Release the c.r.t. from the shield, release the locking clamp at the rear of the shield and slide the tube forward, taking great care not to damage the side pins when doing this. Note that the leads to the trace rotation coil and the e.h.t. cable pass through grommeted holes in the shield. Take care not to strain these leads. It is necessary to remove the contact inserts from the plastic housing of SKK in order to remove the cable. Do not knock or stress the shield as this can damage its magnetic properties.
12. To replace the c.r.t. assembly, reverse the above procedure, but tighten the locking clamp last, after pushing the c.r.t. forward within the shield to meet the front panel moulding. DO NOT overtighten this clamp as damage to the glass may result. Tighten only to the point where the rubber block is seen to distort.

    WARNING: Although the danger of implosion

with this type of c.r.t. is slight, great caution should nevertheless be used when handling the c.r.t. It is advisable to wear protective clothing, in particular, some form of suitable eye protection.

5.2.10 SCALE ILLUMINATION LAMPS

1. Remove the instrument top cover.
2. Pull the lampholder(s) from the plastic moulding around the face of the c.r.t.
3. Pull the wedge shaped base lamp from its socket. The lamps are 12V 1W types, part number 40328.

5.2.11 COAXIAL CONNECTIONS

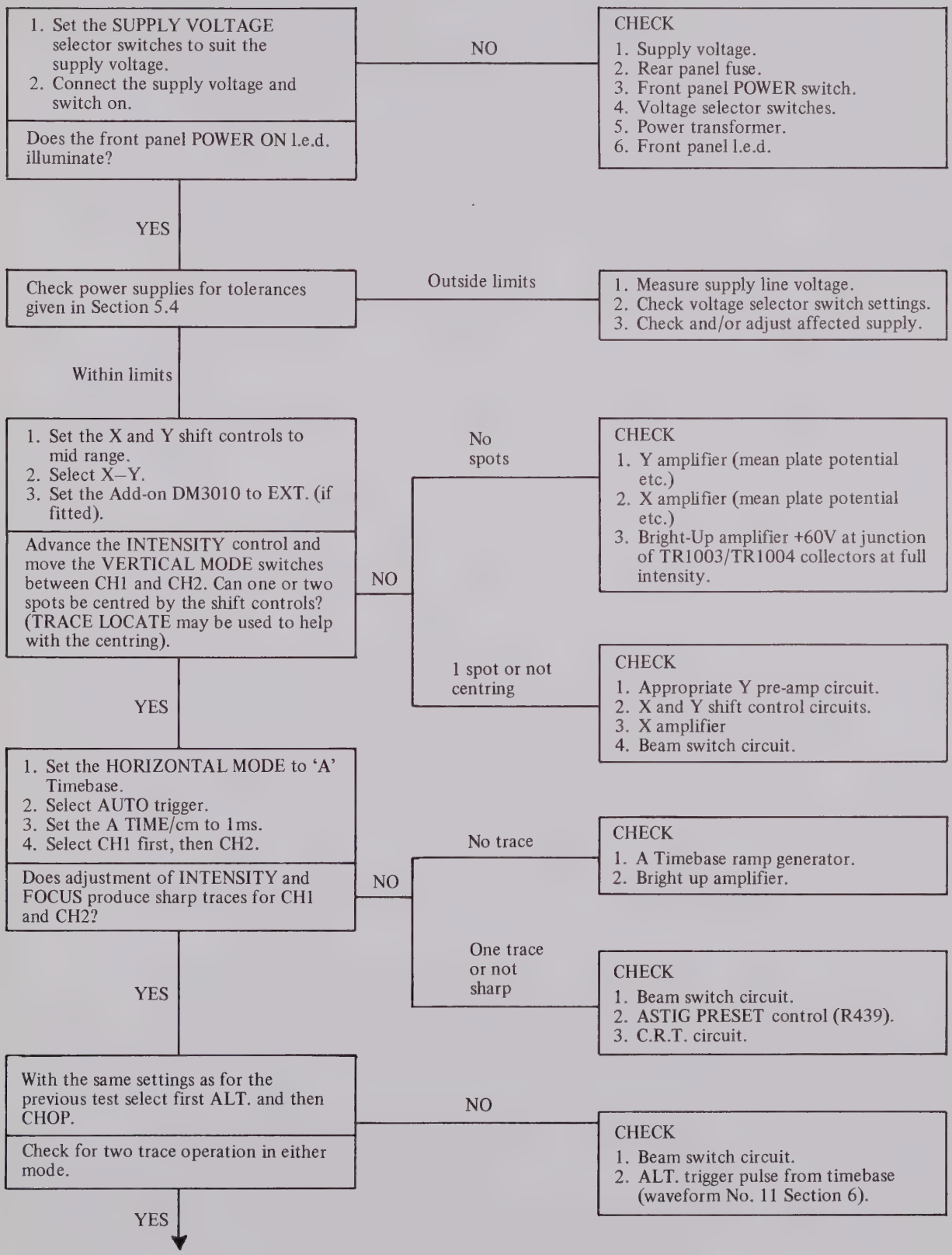
The instrument uses 13 coaxial leads for interconnection between assemblies which are coded with coloured sleeves at each end for identification. The table in Fig. 5.1 shows the interconnection details. The first pin number in a pair refers to the inner conductor, the second to the screen.

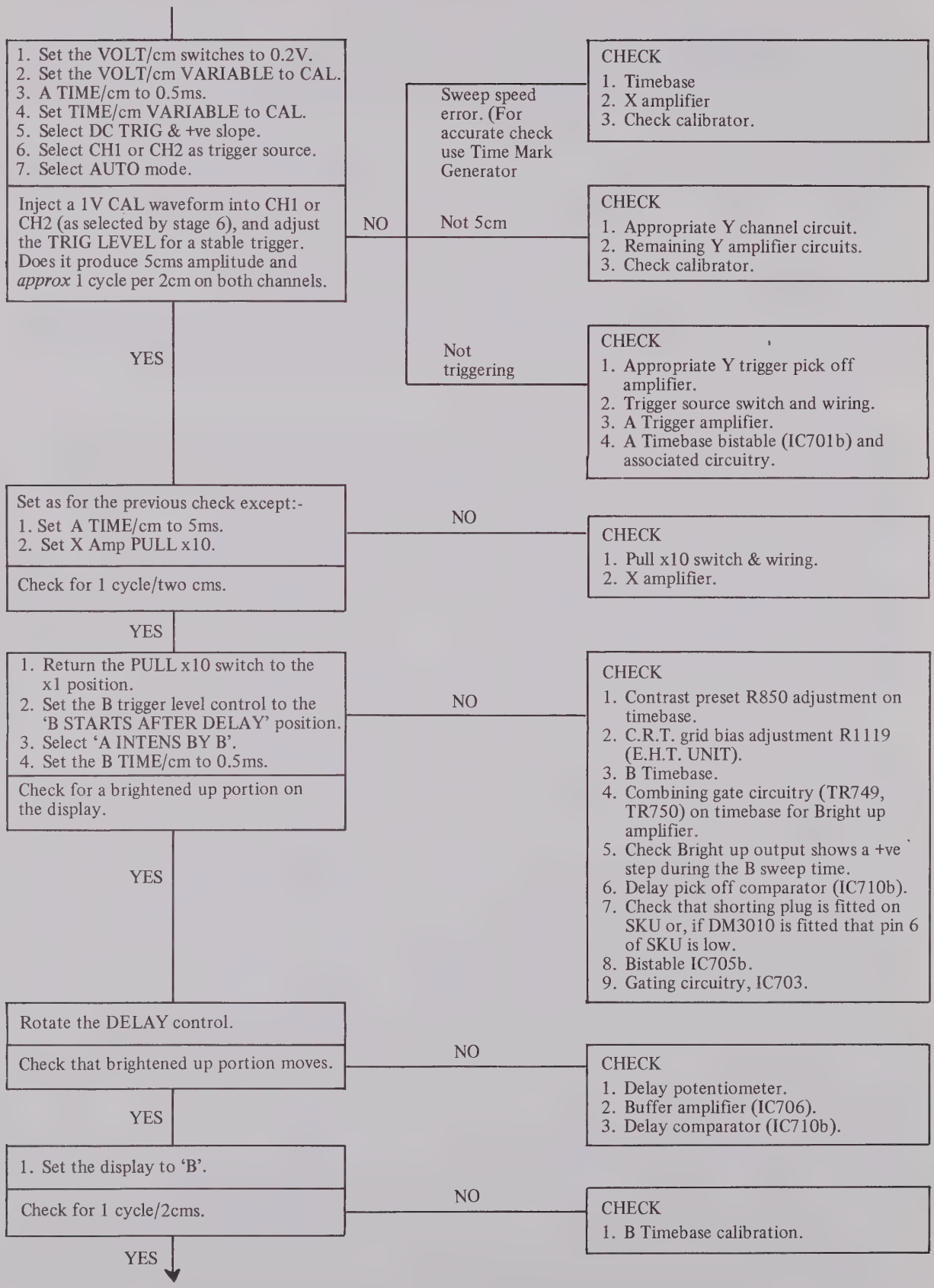
5.3 FAULT FINDING TABLES

Fault finding is based initially on the characteristics of the fault and the tables of Section 5.3 define a suggested procedure to localise the fault to one particular area. Subsequent detailed guidance will be obtained from the relevant circuit diagram and circuit description and from the table of operating potentials in Section 5.4.

FROM	TO
'Y' Preamp p.c.b. pins 302, 301	Timebase p.c.b. pins 715, 716
'Y' Preamp p.c.b. pins 308, 309	Trigger source S511, a3, b3
'Y' Preamp trigger CH1	Trigger source S509, b3, b1
'Y' Preamp trigger CH2	Trigger source S512, b3, b1
'Y' Preamp p.c.b. pins 309, 0V and R308	Power supply p.c.b. pins 1014 and 1016
Ex-Atten p.c.b. pin 626, CAL	Timebase p.c.b. pins 711, 712
Back panel BNC socket (B GATE)	Timebase p.c.b. pins 718, 717
Back panel BNC socket (A RAMP)	Timebase p.c.b. pins 720, 719
Timebase p.c.b. pin 707, 708	Power supply p.c.b. pins 1013, 1015
Trigger source p.c.b. pins 601, 0V	Transformer pins 11 and 12
Timebase p.c.b. pins 703 and 704	Trigger p.c.b. pins 511 and 512
Timebase p.c.b. pins 705 and 706	Trigger p.c.b. pins 554 and 555
Timebase p.c.b. pins 709 and 710	Timebase p.c.b. pins 701 and 702

Fig. 5.1 Coaxial Lead Interconnection Data


1. Set the SUPPLY VOLTAGE selector switches to suit the supply voltage.
2. Connect the supply voltage and switch on.
Does the front panel POWER ON l.e.d. illuminate?
NO
CHECK
1. Supply voltage.
2. Rear panel fuse.
3. Front panel POWER switch.
4. Voltage selector switches.
5. Power transformer.
6. Front panel l.e.d.
YES
Check power supplies for tolerances given in Section 5.4
Outside limits
1. Measure supply line voltage.
2. Check voltage selector switch settings.
3. Check and/or adjust affected supply.
Within limits
1. Set the X and Y shift controls to mid range.
2. Select X–Y.
3. Set the Add-on DM3010 to EXT. (if fitted).
Advance the INTENSITY control and move the VERTICAL MODE switches between CH1 and CH2. Can one or two spots be centred by the shift controls? (TRACE LOCATE may be used to help with the centring).
NO
No spots
CHECK
1. Y amplifier (mean plate potential etc.)
2. X amplifier (mean plate potential etc.)
3. Bright-Up amplifier +60V at junction of TR1003/TR1004 collectors at full intensity.
1 spot or not centring
CHECK
1. Appropriate Y pre-amp circuit.
2. X and Y shift control circuits.
3. X amplifier
4. Beam switch circuit.
YES
1. Set the HORIZONTAL MODE to 'A' Timebase.
2. Select AUTO trigger.
3. Set the A TIME/cm to 1ms.
4. Select CH1 first, then CH2.
Does adjustment of INTENSITY and FOCUS produce sharp traces for CH1 and CH2?
NO
No trace
CHECK
1. A Timebase ramp generator.
2. Bright up amplifier.
One trace or not sharp
CHECK
1. Beam switch circuit.
2. ASTIG PRESET control (R439).
3. C.R.T. circuit.
YES
With the same settings as for the previous test select first ALT. and then CHOP.
Check for two trace operation in either mode.
NO
CHECK
1. Beam switch circuit.
2. ALT. trigger pulse from timebase (waveform No. 11 Section 6).
YES


1. Set the VOLT/cm switches to 0.2V.
2. Set the VOLT/cm VARIABLE to CAL.
3. A TIME/cm to 0.5ms.
4. Set TIME/cm VARIABLE to CAL.
5. Select DC TRIG & +ve slope.
6. Select CH1 or CH2 as trigger source.
7. Select AUTO mode.
Inject a 1V CAL waveform into CH1 or CH2 (as selected by stage 6), and adjust the TRIG LEVEL for a stable trigger. Does it produce 5cms amplitude and *approx* 1 cycle per 2cm on both channels.
NO
Sweep speed error. (For accurate check use Time Mark Generator
CHECK
1. Timebase
2. X amplifier
3. Check calibrator.
Not 5cm
CHECK
1. Appropriate Y channel circuit.
2. Remaining Y amplifier circuits.
3. Check calibrator.
Not triggering
CHECK
1. Appropriate Y trigger pick off amplifier.
2. Trigger source switch and wiring.
3. A Trigger amplifier.
4. A Timebase bistable (IC701b) and associated circuitry.
YES
Set as for the previous check except:-
1. Set A TIME/cm to 5ms.
2. Set X Amp PULL x10.
Check for 1 cycle/two cms.
NO
CHECK
1. Pull x10 switch & wiring.
2. X amplifier.
YES
1. Return the PULL x10 switch to the x1 position.
2. Set the B trigger level control to the 'B STARTS AFTER DELAY' position.
3. Select 'A INTENS BY B'.
4. Set the B TIME/cm to 0.5ms.
Check for a brightened up portion on the display.
NO
CHECK
1. Contrast preset R850 adjustment on timebase.
2. C.R.T. grid bias adjustment R1119 (E.H.T. UNIT).
3. B Timebase.
4. Combining gate circuitry (TR749, TR750) on timebase for Bright up amplifier.
5. Check Bright up output shows a +ve step during the B sweep time.
6. Delay pick off comparator (IC710b).
7. Check that shorting plug is fitted on SKU or, if DM3010 is fitted that pin 6 of SKU is low.
8. Bistable IC705b.
9. Gating circuitry, IC703.
YES
Rotate the DELAY control.
Check that brightened up portion moves.
NO
CHECK
1. Delay potentiometer.
2. Buffer amplifier (IC706).
3. Delay comparator (IC710b).
YES
1. Set the display to 'B'.
Check for 1 cycle/2cms.
NO
CHECK
1. B Timebase calibration.
YES

1. Set the display to 'A INTENS BY B'
2. Set the B trigger to +ve slope and to the appropriate Y channel input.
3. Turn the trigger level away from the 'B STARTS AFTER DELAY' position & adjust for a stable display.

Check that rotation of the DELAY control causes trigger point to jump from one edge to the next.

NO

CHECK
1. B Trigger amplifier
2. B Trigger gating (IC703).

YES

1. Select A & B ALT.
2. Set B TRIG LEVEL to 'B STARTS AFTER DELAY'
3. Set A TIME/cm to 2ms.
4. Set B TIME/cm to 0.5ms.

Check that the A intensified sweep and the B sweep are displayed and that the TRACE SEPARATION control is functional.

NO

No alternating A & B trace

CHECK
1. A & B Alt switch S704
2. Display Bistable IC708.
3. ALT pulse gate IC707.

No trace separation

CHECK
1. Differential Amp. TR741/742.
2. Analogue switch IC709.
3. TRACE SEPARATION control.
4. Wiring connection to Y amp.

YES

1. Select 'A' only.
2. Set A TIME/cm to 0.5s.
3. Select NORMAL trigger and adjust the 'A' level for a stable trigger.
4. Set the Y input to the GND position and check that triggering stops.

Select SINGLE SWEEP. The 'ARMED' indicator should light. Now remove the GND from the Y input and a single sweep should be displayed.

NO

No 'ARMED' indication

CHECK
1. l.e.d. indicator and wiring.
2. TR701 & circuitry.
3. Switch S708 (S. Sweep).
4. Single Shot Bistable IC701a.

No sweep

CHECK
1. Single Shot bistable IC701a.
2. Switch S708 (S. Sweep).

YES

1. Select 'A' only.
2. Set 'A' TIME/cm to 0.5ms.
3. Select CH1 and TRIG VIEW.
4. Apply a 1V squarewave signal.
5. Set CH1 to 0.5V/cm.

Check that two traces appear on the c.r.t., one of which is adjustable by the TRIG LEVEL control. If the TRIG LEVEL is adjusted so that the signal waveform does not pass through the centre of the screen then triggering should cease. The TRIG VIEW waveform should be approx. 4 cm in amplitude.

NO

No TRIG VIEW trace

CHECK
1. Y Beam Switch
2. Trig View signal wiring.
3. Trig View pick off amp.
4. Trig View inhibit line (SKS pin 7).

Trig View does not balance in centre of c.r.t. or amplitude incorrect.

CHECK
1. Trig View balance (R382).
2. DC TRIG BAL R184, 284 (on D.C. Trig only).
3. Trigger amp or Trigger pick off amp gain.

FOR INSTRUMENTS FITTED WITH DM3010

1. Select time measurement.
2. Select 'A INTENS BY B'
3. Set DM3010 V/T control to maximum.
4. Select CH1 or CH2.

Check that for each 'A' timebase range the DM3010 reads the correct FSD, with the correct time notation (i.e. s, ms, μs) and decimal point.
e.g. 50ns/cm should read 0.5μs FSD.

NO →
CHECK
1. A TIME/cm switch.
2. Wiring harness to DM3010.
3. DM3010 Logic.
4. DM3010 calibration.
5. V/T control.

YES ↓

1. Set the A TIME/cm to 20μs.
2. Set the B TIME/cm to 1μs.
3. Apply 10μs markers.
4. Set the DELAY control to the minimum value which aligns the 1st Bright up with the first available marker.
5. Set the V/T control to maximum.

Check that two Bright ups occur on the display 10 cm apart and that the final Bright up corresponds with the 20th marker.

NO →
Only one Bright up →
CHECK
1. Delay comparator (IC710).
2. Bistable IC705b.
3. Wiring harness to SKU.
4. DM3010 time switches (S8 & S9).

Both Bright ups will not align with markers →
CHECK
1. A Timebase calibration.
2. DM3010 V/T control calibration.
3. Delay comparators (Ic710 a & b).

YES ↓

1. With the settings as for the previous check except select 'B' only.

Check that the marker from first Delay sweep aligns with the marker from the second Delay sweep within the calibration specification.

NO →
CHECK
1. A Timebase calibration.
2. DM3010 V/T control calibration.

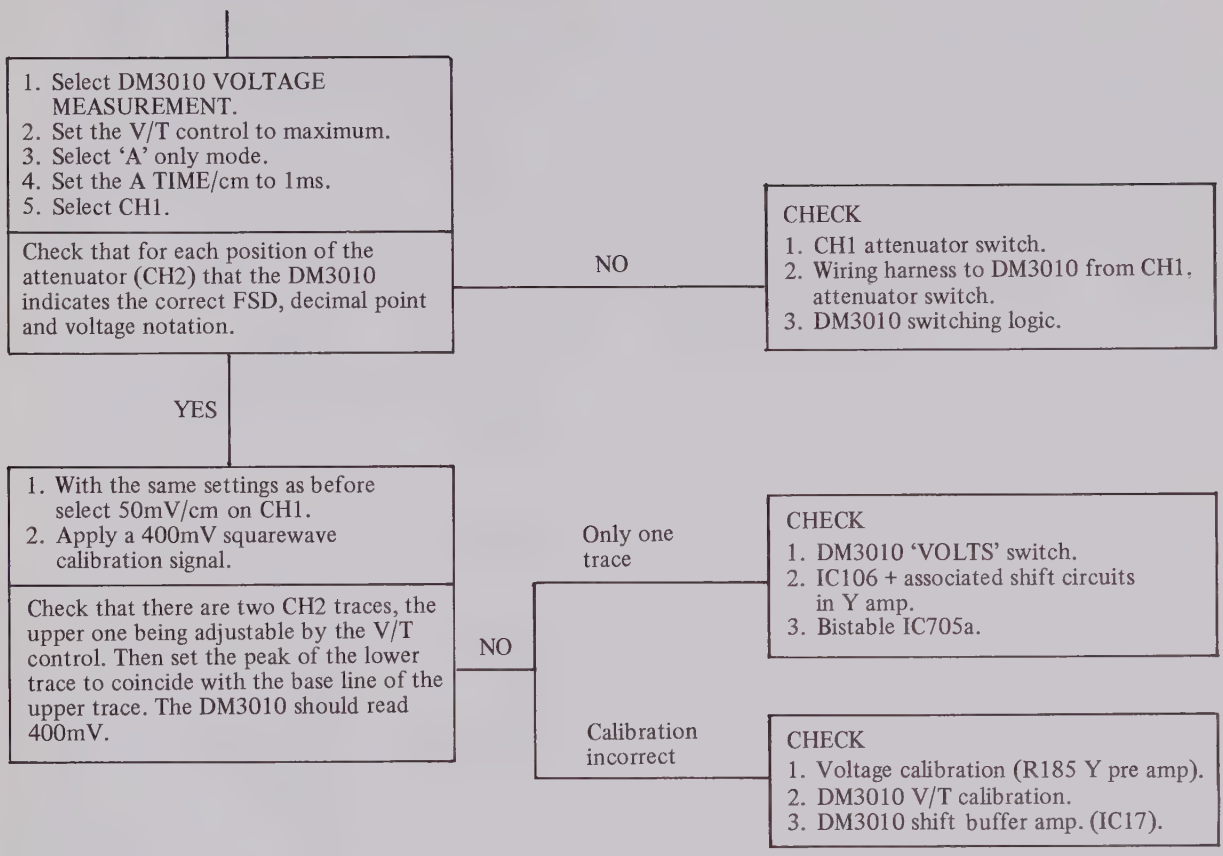
YES ↓

1. Using the same setting as for the previous check except select CH1 & CH2 ALT.

Check that the first Bright up occurs on CH1 and the second on CH2 and that the 'B' traces correspond to the respective channels.

NO →
CHECK
1. Bistable IC705b.
2. Channel switch phasing (Pin 18 SKT to TR747).
3. Display bistables IC708a & IC708b.
4. Gate IC707.

YES ↓


1. Select DM3010 VOLTAGE MEASUREMENT.
2. Set the V/T control to maximum.
3. Select 'A' only mode.
4. Set the A TIME/cm to 1ms.
5. Select CH1.
Check that for each position of the attenuator (CH2) that the DM3010 indicates the correct FSD, decimal point and voltage notation.
NO
CHECK
1. CH1 attenuator switch.
2. Wiring harness to DM3010 from CH1. attenuator switch.
3. DM3010 switching logic.
YES
1. With the same settings as before select 50mV/cm on CH1.
2. Apply a 400mV squarewave calibration signal.
Check that there are two CH2 traces, the upper one being adjustable by the V/T control. Then set the peak of the lower trace to coincide with the base line of the upper trace. The DM3010 should read 400mV.
NO
Only one trace
CHECK
1. DM3010 'VOLTS' switch.
2. IC106 + associated shift circuits in Y amp.
3. Bistable IC705a.
Calibration incorrect
CHECK
1. Voltage calibration (R185 Y pre amp).
2. DM3010 V/T calibration.
3. DM3010 shift buffer amp. (IC17).

5.4 OPERATING POTENTIALS

Measurements are taken with the power supply input voltage at approximately the mid range of the supply voltage setting. The Y inputs are grounded and the amplifiers set to 2mV/cm sensitivity. The Timebase is set to A only and AUTO, with the trigger LEVEL control fully clockwise. The Y amplifier is set to CH1 only with the trace centred except where stated. To prevent possible oscillation measurements were taken with a 1kΩ resistor in series with the meter lead.

Y PREAMPLIFIER AND PREAMP TRIGGER

CH1

Set DM3010 to NORMAL mode (if fitted)

TR102	EMITTER	-6.5V
TR103	BASE	+0.73V
IC101	PIN 6	-4.5V
IC102	PINS 1, 7	-0.8V
TR104, 105	EMITTERS	+3.3V
"	COLLECTORS	-5.2V
IC103	PINS 5, 6	-6.0V
"	PINS 1, 2, 9, 10	-1.25V
IC104	PINS 8, 11	+2.0V
"	PINS 3, 4, 5, 13	-5.3V
TR106	EMITTER	-4.6V
TR107	EMITTER	-5.25V
TR109	COLLECTOR	+0.89V
TR108	COLLECTOR	-9.5V
TR108, 109	EMITTERS	+6.8V
IC105	PINS 1, 5, 6, 9	-1.9V
"	PIN 3	-7.2V
TR110, 111	EMITTERS	-3.5V

CH2

CH2 only selected and trace centred.

TR202	EMITTER	-6.5V
TR103	BASE	+0.73V
IC101	PIN 6	-4.5V
IC102	PINS 1, 7	-0.8V
TR104, 105	EMITTERS	+3.3V
"	COLLECTORS	-5.2V
IC103	PINS 5, 6	-6.0V
"	PINS 1, 2, 9, 10	-1.25V
IC104	PINS 8, 11	+2.0V
"	PINS 3, 4, 5, 13	-5.3V
IC105	PINS 1, 5, 6, 9	-1.9V
"	PIN 3	-7.2V
TR110, 111	EMITTERS	-3.5V
IC107, 207	PINS 5, 6	+1.2V
IC301	PINS 5, 6	+0.2V
TR303, 304	BASES	+4.7V
IC302	PINS 8, 11	+5.6V
"	PINS7, 9	+3.0V
IC302	PIN 3	+1.3V
TR312	EMITTER	+1.3V
IC307	PIN 11	+11.7V
IC307	PIN 8	0V
TR306	COLLECTOR	+0.2V
TR305	COLLECTOR	-0.1V

Y DRIVER AND OUTPUT

TR401, 402	COLLECTOR	-3.4V
TR403, 404	EMITTERS	-7.2V
"	COLLECTORS	+1.2V
Y DRIVER O/P	PINS 405, 409	+5.9V
Y OUTPUT	PINS 475, 476	+33V
*FOCUS	PLH (4)	-1.5kV approx.

*HIGH IMPEDANCE – REFOCUS AFTER CONNECTING METER

GEOMETRY	PIN 404	+20V approx.

TRIGGER AMPLIFIER

Trig level controls (A and B) set to mid position, no trigger signal applied.

A CHANNEL

TR503	BASE	0V
TR507	BASE	-0.71V
TR508	BASE	-1.0V
TR507/508	COLLECTORS	+2.8V
TR506	EMITTER	+8.9V (XY sel.)
"	"	+1.9V (XY not sel.)
TR509, 510	COLLECTORS	-0.56V
TR513, 514	"	+3.6V
IC501	PIN 5	+3.6V (POS. TRIG)
"	"	+4.3V (NEG. TRIG)
"	PIN 10	+2.0V (POS. TRIG)
"	"	+3.6V (NEG TRIG)
TR515	EMITTER	-4.7V
TR517	EMITTER	-7.6V
TR511, 512	COLLECTORS	+5.5V (TRIG VIEW SEL)

B CHANNEL

TR522	BASE	0V
TR524	BASE	-0.74V
TR525	BASE	-1.0V
TR524/525	COLLECTORS	+3.6V
TR526	COLLECTORS	-1.2V
TR528/529	COLLECTORS	+3.0V
IC502	PIN 5	+4.3V (POS TRIG)
"	"	+3.6V (NEG TRIG)
"	PIN 10	+3.6V (POS TRIG)

”	”	+2.0V (NEG TRIG)

TIMEBASE

Readings are taken with A ONLY and NORMAL TRIG. modes selected with no trigger signal applied. All controls are in the CH1 position, except where stated.

TR714	BASE	+14.5V
TR738	”	+14.5V
TR714	”	+21V *
TR738	”	+21V *

* A & B variable TIME/CM fully anticlockwise

TR720	EMITTER	0V
TR710	”	-8.3V
TR703	”	+4V
TR735	”	0V
TR727	”	-8.6V
TR726	”	+3.0V
TR749	BASE	-2.2V
TR750	COLLECTOR	+30V

X OUTPUT AMPLIFIER

Readings are taken with the HORIZONTAL mode switched to X-Y, the A TRIGGER SOURCE to EXT and the X SHIFT adjusted for a spot in the centre of the c.r.t.

TR814	EMITTER	-11.8V
TR810/812	BASES	+1.8V
TR809, 811	BASES	+1.8V
TR813	EMITTER	-3.8V
TR805	BASE	+6.9V
TR806	”	+7.6V
TR807	”	+8.9V
TR808	”	+7.6V
TR801/803/802 /804	COLLECTORS	+60V

POWER SUPPLY

Readings are taken with the HORIZONTAL MODE switched to X-Y and the spot centred and just visible.

IC1001	ADJ	+10.8V
IC1002	ADJ	-10.8V
IC1004	PINS 1, 6, 10	+24V
”	PINS 7, 8	+30V
”	PIN 5	+12V
IC1003	ADJ	+3.8V
TR1005	COLLECTOR	+79V
TR1004	COLLECTOR	+15V
TR1003	COLLECTOR	-11V
PLA	PIN 5 (mean plate)	+30V
PLA	PIN 6 (ASTIG)	+30V approx.

C.R.T. FINAL ANODE

Remove the screen from the e.h.t. assembly. Remove and discharge the c.r.t. final anode socket from the voltage multiplier MPR1. Measure the final anode voltage at the output from the multiplier.

MPR1	OUTPUT PLUG	14.3kV

BEWARE HIGH VOLTAGE – OBSERVE ALL PRECAUTIONS LISTED IN SECTION 5.2.7.

5.5 CALIBRATION PROCEDURE

5.5.1 TEST EQUIPMENT

1. Variable autotransformer. Output voltage 95-260V at 1A with r.m.s. voltmeter.
2. Digital multimeter 4½ digit with 1MΩ minimum input impedance and accuracy within 0.02%.
3. High voltage probe for multimeter capable of operation up to 20kV.
4. Voltage calibrator 1kHz square wave generator with amplitude range of 2mV to 50V ±0.2%.
5. Time mark generator. 10ns to 0.5s ±0.2%.
6. Fast rise squarewave generator. 100Hz to 1MHz flat top square wave generator with amplitude range 0.1V to 1V into 50Ω with rise time of less than 1ns.
7. R.F. sinewave generator 500kHz to 150MHz with 50kHz reference frequency. Output amplitude 10mV to 5Vpp into 50Ω, accuracy at 50kHz and 500kHz to 150MHz within 3%.
8. LF Sinewave generator.
9. Capacitance standardiser 1MΩ/25pF, BNC 50Ω terminations.
10. BNC–BNC connector lead (PL43).
11. Test oscilloscope, 10MHz bandwidth $\geqslant$ 5% accuracy $\leqslant$ 50mV/cm sensitivity with X10 low capacitance probe.

NOTE: Calibration should be carried out at 23°C ambient temperature after at least a 15 minute warm up period. All measurements are made with respect to chassis except where stated.

5.5.2 POWER SUPPLIES AND CALIBRATOR

1. Set the INTENSITY control to minimum.
2. Set the supply voltage switches in the rear panel to suit the supply. Apply the supply voltage via the variac and set to mid range of the supply voltage setting. (Check the correct supply fuse has been fitted).
3. Check the SCALE control varies the scale intensity and that the POWER ON l.e.d. is energised.
4. Connect the d.v.m. to pin 6 on PLD (power supply p.c.b.), set R1052 to give -12.00V.
5. Check the supply voltages on the following pins of PLD.

PLD (9)	5.0V ±5%
PLD (4)	24.0V ±5%
PLD (1)	+120V ±6%
PLD (3)	−120V ±6%

6. Connect a d.v.m. to the anode (orange lead) of C1 (1000μF 100V) and check for 60V ±6%).
7. Briefly switch off the instrument, remove IC714 on the timebase p.c.b. and switch on again, connect the d.v.m. to the 1V CAL pin. Adjust R1051 on the power supply p.c.b. for 1.000Vd.c. output. Connect the d.v.m. to PLD(6) and check for +12V ±2%. Briefly switch off the set, replace IC714 and switch on again. Confirm with an oscilloscope the presence of a square wave at the CAL output of frequency 1kHz ±10%.

5.5.3 E.H.T. AND C.R.T. CUT OFF VOLTAGES

1. Remove the screen from the e.h.t. oscillator.
2. Connect the d.v.m. via the high voltage probe to the cathode (positive band) of D1114. Adjust R1106 for −2.2kV.

   BEWARE HIGH VOLTAGE.
3. Set the instrument to X-Y mode and centre the spot on the screen. Adjust the INTENSITY control for +15V at the junction of the collectors of TR1003, TR1004 and R1022. The set R1119 for a just visible spot.
4. Replace the e.h.t. screen.

5.5.4 Y MEAN PLATE POTENTIAL AND +7V SUPPLY

1. Measure the +7V supply at pin 408 on the Y driver p.c.b., check for +7V ±0.5V, if necessary adjust R425 (A.O.T.) to achieve this.
2. Set trace to centre line. Measure the Y plate voltages and finely adjust the Y shift control to equalise the voltages. Check the voltage lies in the range +29 to 33V. Adjust R456 (A.O.T.) if necessary.

5.5.5 TRACE ALIGNMENT GEOMETRY AND ASTIGMATISM

1. Set the instrument to 1ms/cm, 50mV/cm with trigger to AUTO timebase to A ONLY and Y MODE to CH1.
2. Ground CH1 input and centre trace, adjust TRACE ROTATE control for a horizontal trace. (It may be necessary to reverse SKV).
3. Set CH1 input to AC. Apply a 1MHz sinewave of approximately 400mV amplitude. Trigger the signal and adjust the GEOM preset R440 for best compromise of the X and Y edges at the extreme edges of the graticule.
4. Apply a 1kHz sinewave of approximately 400mV amplitude. Trigger the waveform and adjust the ASTIG preset R439 in conjunction with the FOCUS control for the finest trace at low intensity.
5. Recheck the geometry setting.

5.5.6 SCALE ILLUMINATION

Check both lamps are operating, replace if showing signs of blackening. Check that brilliance is fully variable.

Y AMPLIFIER ADJUSTMENTS

5.5.7 CHANNELS 1 & 2 – AC/DC EQUALISATION

1. Set the instrument to CH1 only, 10mV/cm sensitivity d.c. coupled, triggered from CH1 a.c. coupled, A timebase only 5ms/cm.
2. Apply a 100Hz square wave via 25pF capacitance standardiser and adjust R178 for a flat top to the waveform.
3. Repeat for R278 for channel 2.

5.5.8 CHANNELS 1 & 2 – DC STEP ATTENUATOR BALANCE

1. Set to CH1 only, 20mV/cm sensitivity, input grounded, A timebase free running (AUTO).
2. Centre the trace and adjust R179 so that there is no trace movement when the attenuator is switched between 20mV/cm and 50mV/cm.
3. Repeat for Channel 1 2/5mV balance adjusting R180.
4. Repeat for Channel 2, 20/50mV balance adjusting R279.
5. Repeat for Channel 2, 2/5mV balance adjusting R280.

5.5.9 CHANNELS 1 & 2 – INVERT BALANCE

1. Set the instrument as for 5.5.8 1. above.
2. Centre the trace and adjust R182 for no movement when the invert switch is operated.
3. Repeat for Channel 2, adjusting R282.

5.5.10 OUTPUT BALANCE

1. Set the instrument to CH1 only, 10mV/cm.
2. Apply 100MHz from the generator and adjust for 4cm display. Trigger the waveform.
3. Adjust R341 so that any limiting that occurs as the shift control is operated is symmetrical about the centre of the graticule.

5.5.11 ADD MODE BALANCE

1. Set the instrument to DUAL, free run the timebase and centre both traces.
2. Check that when ADD is selected trace movement is less that 5mm. If necessary, adjust either R333 (A.O.T.) or R334 (A.O.T.) to achieve this.

5.5.12 CHANNELS 1 & 2 GAIN CALIBRATION

1. Set the instrument to CH1 only, 10mV/cm. Apply

a 50mV peak to peak squarewave from an oscilloscope calibrator, set the timebase to a suitable speed and trigger the waveform. Adjust R181 for exactly 5cm amplitude.

2. Set the instrument to 2mV/cm. Apply 10mV p.p. and adjust R183 for exactly 5cm amplitude.
3. Check the variable gain pot reduces the display amplitude to between 1 and 2cm, and is smooth in operation. Check the "UNCAL" l.e.d. operates.
4. Repeat step 1 for CH2 adjusting R281.
5. Repeat step 2 for CH2 adjusting R283.
6. Repeat step 3 for CH2.

5.5.13 CHANNELS 1 & 2 ATTENUATOR COMPENSATION

1. Select CH1 only 0.1V/cm, set the calibrator to give 5cm amplitude, adjust C65 for a square corner.
2. Select 1V/cm sensitivity, reset the calibrator and adjust C67 for a square corner.
3. Fit a 25pF capacitance standardiser in series with the input, select 10mV/cm sensitivity and adjust C69 for a square corner.
4. Select 0.1V/cm and repeat adjusting C71.
5. Select 1V/cm and repeat adjusting C73.
6. Select CH2 only and repeat steps 1–5 above, adjusting C66, 68, 70, 72, 74 respectively.

5.5.14 CH1 & CH2 ATTENUATOR ACCURACY

Using the calibrator, check all attenuator ranges on both channels for ±3% accuracy and square corner.

5.5.15 CH1 & CH2 INVERT SWITCHES

Invert a 5cm square wave and check that the amplitude does not change.

5.5.16 CH1 & CH2 INPUT LEAKAGE

Select 2mV/cm sensitivity and check that the trace movement when the input coupling is switched from DC to GND is less that 1mm on both channels.

5.5.17 Y AMPLIFIER PULSE RESPONSE

NOTE: If there is any reason to suspect that there are significant timebase H.F. calibration errors, these should be checked and rectified before proceeding further as the pulse response measurements will otherwise be invalid.

1. Select Channel 1, 10mV/cm, d.c. coupled A timebase only to 0.1μs/cm. Apply a 1ns risetime pulse, 1MHz repetition rate via a 50Ω termination and adjust the level to give about 5cm amplitude.
2. Adjust C125 and C313 on the pre-amplifier and C408 and 409 on the output driver for optimum pulse responses paying particular attention to obtaining a square corner. It will be necessary to adjust each trimmer several times to achieve the best compromise.
3. Select Channel 2 10mV/cm d.c. coupled and adjust C225 for optimum pulse response, also readjusting C313 if necessary to obtain the best compromise and similarity between both channels.
4. Recheck channel 1 and readjust C125 if necessary.
5. Check the risetime < 3.5ns on both channels.
6. Recheck the pulse response with a 100kHz repetition rate pulse.

5.5.18 Y BANDWIDTH

1. Select channel 1 10mV/cm sensitivity d.c. coupled. Connect a constant Amplitude Generator via a 50Ω termination.
2. Switch to the reference frequency and adjust for 5cm deflection. Increase the generator frequency until the amplitude displayed drops to 3.5cm. The frequency should be greater that 100MHz.
3. Check the bandwidth on the 50mV, 20mV, 5mV and 2mV ranges. All should be greater than 100MHz, except the 2mV range which should be greater than 85MHz.
4. Repeat the procedure for channel 2. Should the bandwidth prove inadequate recheck the pulse response, paying particular attention to obtaining a square corner.

TIMEBASE ADJUSTMENTS

5.5.19 X MEAN PLATE POTENTIAL

1. Set the timebase to 0.1ms/cm x1, A only, the trigger to AUTO and the trigger level for a stable trace.
2. Adjust shift control to bring the start of the trace to the centre of the screen. Using the test oscilloscope, check that the sweep start voltage on each plate lies between +26V and +32V. Adjust AOT resistor R972 if necessary to achieve this.
3. Repeat for x10 expansion, adjusting R971 if necessary.

5.5.20 PRESET CONTRAST

1. Set the timebase to A intensified by B, 0.2ms/cm (A), 50μs/cm (B), delay to 3.0.
2. Adjust R850 for 8V "B" bright-up step at the junction of the collectors of TR1003 and TR1004 measured with the test oscilloscope. There transistors are on the power supply p.c.b. BEWARE HIGH VOLTAGE ON THE P.C.B.

5.5.21 A TRIGGER BALANCE ADJUSTMENTS

1. Set the instrument to AC, CH1, A only, 0.1ms/cm and AUTO. Apply a 10kHz sinewave of about 6cms amplitude on the display, set the A TRIGGER LEVEL to centre and the input to AC TRIGGER coupling, with CH1 as source. Adjust R520 on the

trigger p.c.b. for the trace to start approximately central in the waveform.

2. Set the TRIGGER COUPLING to DC, adjust R184 (DC TRIG. BAL.) on the Y preamplifier p.c.b. for no trigger level movement between DC coupling and AC coupling. Select the TRIGGER SOURCE to CH2, apply the input signal and repeat the procedure with R284 (CH2 DC TRIG. BAL.).
3. Select CH1 and CH2 ALTERNATE, Y inputs to AC and position both traces central on the graticule. Apply the same 10kHz input to both channels. Select COMPOSITE TRIGGER SOURCE and adjust R356 (COMP. TRIG. BAL.) on the preamplifier p.c.b. for no trace movement between AC and DC trigger coupling.
4. Select CH1 and apply a low level signal to occupy about 2mm of trace. Adjust the trigger level for stable trigger and select the TRIGGER VIEW facility. Adjust the TRIGGER VIEW BALANCE R382 for a "TRIGGER VIEW" trace in the centre of the c.r.t.

5.5.22 B TRIGGER ADJUSTMENT

1. Select CH1, AC TRIGGER SOURCES A to B to CH1, with TRIG COUPLING on AC. Set A timebase to 0.2ms/cm and B timebase to 0.1ms/cm. Select A INTENS BY B.
2. Adjust the A TRIGGER LEVEL control for a stable trigger with a 10kHz sinewave applied to CH1. (about 6cms).
3. Adjust the B TRIGGER LEVEL control for an intensified B trace. Change the HORIZONTAL MODE to B ONLY.
4. Set the B TRIGGER LEVEL control to centre and adjust R609 (B TRIG LEVEL BAL) for the start of trace to commence at the mid-point of the sinewave amplitude. Return to A ONLY and B STARTS AFTER DELAY.

5.5.23 EXTERNAL X A COMPENSATION

1. Set TRIGGER SOURCE to EXT and the VERTICAL MODE to TRIG VIEW, TRIGGER COUPLING to DC. Apply no LF or HF REJECT.
2. Apply a 0.25V 1kHz square wave from the calibrator to the EXT A input and adjust C588 for a square corner on the waveform.
3. Apply 0.5V 1kHz via a 25pF standardiser and adjust C589 for a flat top to the waveform.
4. Apply a 2.5V 1kHz direct, select EXT ÷ 10 and adjust C545 and C547 for a square corner and flat top.

5.5.24 EXTERNAL X B COMPENSATION

1. Centre the B TRIG LEVEL control. Set the TRIGGER SOURCE to EXT and TRIGGER COUPLING TO DC. Connect the probe of the test oscilloscope to the emitter of TR522.
2. Apply a 2.5V 1kHz square wave from the calibrator to the EXT B input and adjust C581 for a square corner to the displayed waveform.
3. Apply 5V 1kHz via the standardiser and adjust C583 for a flat top to the waveform.
4. Apply 5V 1kHz direct, select EXT ÷ 10 and adjust C562 and C563 for a square corner and flat top.

5.5.25 A TIMEBASE CALIBRATION

1. Set the Y VERTICAL MODE to CH1 with input at DC, 1V/cm. Set the HORIZONTAL MODE to ' A INTENS BY B'. A TIME/cm to 1ms, B TIME/cm to 1μs.
2. Using the digital multimeter set on the 10V range apply to the tags of the DELAY control which connect to pins 10 and 11 of SKV. Adjust R915 for a reading of 4.00 volts.
3. Set the DELAY control to minimum and adjust the X shift control for the intensified trace to begin at the first graticule vertical marking. Set the DELAY control to maximum and adjust R960 for the intensified trace to begin on the last graticule vertical marking. Return the DELAY control to minimum again and check the intensified trace alignment with the first vertical. Re-adjust R960 as necessary such that full adjustment of the DELAY control gives 10cm of movement on the intensified trace ±2mm.
4. Select 'A' only and apply 0.1ms markers from the TIMEMARK GENERATOR to the CH1 input. Adjust R767 for 1 pulse/cm with the A TIME/cm set at 0.1ms/cm.
5. Apply 1μs markers, set the A TIME/cm to 1μs/cm and adjust C722 for 1 pulse/cm.
6. Apply 1ms markers, set the A TIME/cm to 1ms/cm and adjust R761 for 1 pulse/cm.
7. Apply 10μs/cm markers, set the TIME/cm to 0.1ms/cm, pull x10 switch and adjust R957 for one pulse/cm.
8. Set the trimmers C815 and C816 for minimum, and apply 10ns markers. The A TIME/cm should be set to 50ns/cm and the x10 switch pulled on, set C815 and C816 by adjusting in equal amounts of capacitance on each such that the best trace linearity and accuracy are obtained. One pulse every 2cm should be displayed.

5.5.26 B TIMEBASE CALIBRATION

1. Select the HORIZONTAL MODE to 'B' and apply an input of 0.1ms markers. Set the A TIME/cm to 0.2ms/cm and the B TIME/cm to 0.1ms/cm. The DELAY control should be set to zero and the 'B TRIGGER LEVEL' at the B STARTS AFTER

DELAY position. Adjust R833 for one pulse/cm.

2. Apply 1μs markers, set the A TIME/cm to 2μs/cm and the B TIME/cm to 1μs/cm. Adjust C741 for 1 pulse/cm.
3. Apply 1ms markers, set the A TIME/cm to 2ms/cm and the B TIME/cm to 1ms/cm. Adjust R816 for 1 pulse/cm.
4. Set the A TIME/cm to 0.2ms/cm and the B TIME/cm to 0.1ms/cm. Select A & B ALTERNATE MODE, check that the A trace and B trace start within ±2mm of each other. If not, change R827 (nominally 470Ω) AOT to suit. R827 should be changed to 560Ω if the B trace starts early or to 390Ω if it starts late.

5.5.27 X-Y CALIBRATION

1. Apply a 160mV 1kHx square wave signal at CH1 with the CH1 attenuator at 20mV/cm and input d.c. coupled. Select CH2 VERTICAL MODE & GROUNDED, CH1 TRIGGER SOURCE AND DC TRIGGER COUPLING.
2. Select X-Y MODE and adjust R512 on the Trigger p.c.b. for exactly 8cm of horizontal display. (Note the calibration specification CH1 ±5% CH2 ±15%).

5.5.28 X-Y PHASE ALIGNMENT

1. Apply 5cms of 50kHz reference signal from an HF signal generator to CH1 & CH2 inputs. A 45° line trace should now be visible on the c.r.t.
2. Increase the frequency to 500kHz and the line may be observed to open out to an ellipse. Adjust the value of C506 (220pF) AOT for the ellipse to close to a line again. Check that the line does not separate more that 2mm for frequencies up to 500kHz.

5.6 CALIBRATION PROCEDURE WITH DM3010 OPTION

NOTE: It is assumed that the oscilloscope has been set according to the calibration details and that the internal set up procedure for the DM3010 has been followed in accordance with the DM3010 handbook.

5.6.1 TIMEBASE – TIME MEASUREMENT CALIBRATION

This setting procedure for the timebase with the DM3010 involves some repetition of oscilloscope adjustments described in Section 5.5 of this handbook but with the special requirements of the add on d.v.m. and the greater setting accuracy needed. All variable controls should be set to the CAL positions.

1. Select CH1 VERTICAL MODE with INPUT COUPLING at DC and Y sensitivity at about 1V/cm (suitable to display about 5cm of Timemark Generator amplitude).
2. Insert the Timemark Generator to CH1 input. Set the HORIZONTAL MODE to A INTENS BY B. Set the A TIME/cm to 0.1ms and the B TIME/cm to 1μs. Apply 10μs markers.
3. Set the DELAY control to near to minimum on the oscilloscope and the v/t control on the DM3010 control to minimum. Select TIME MEASURE and INPUT SCOPE on the DM3010.
4. Pull the X x10 switch and observe the bright-ups at the beginning of the sweep. Adjust R96 on the DM3010 for alignment of the two bright-ups. The slope of the marker signal is useful for achieving this. Adjust the oscilloscope DELAY control to align with the leading edge of the first marker, and the R96 for coincidence.
5. Turn the front panel v/t control to its fully clockwise end. Using the 4½ digit DVM, measure the voltage between pin 11 (the wiper of R18) and pin 10 (0V). Adjust R54 in the DM3010 for a reading of 4.000V.
6. Apply 0.1ms markers. Return the x10 switch to the x1 position. Increase the v/t control to maximum. The DM3010 should display 1.000ms ±12 digits. Adjust R960 (X AMPLIFIER x 1 GAIN) for the two bright-ups to appear exactly 10cms apart. Adjust preset R767 so that 1 marker/cm is displayed.
7. Apply 50μs markers. Advance the DELAY control (OS3600) such that the first bright-up occurs on the first available marker and check that the 21st available marker is intensified by the second bright-up. Now press the B ONLY mode. Readjust R767 for exact coincidence of the two B traces.
8. Return the v/t control to read 0.500ms and check that the 11th marker is displayed. (Return to the A INTENS B position to check this). Adjust the v/t control for coincidence of the 1st and 11th markers on the B traces and check that the DM3010 reads 0.500ms ±7 digits. Return the v/t control to maximum.
9. Set the A TIME/cm switch to 1μs and the B TIME/cm to 100ns. Apply 500ns markers. Select the A INTENS BY B mode. Set the DELAY control for the first bright-up to occur on the first available marker. With the v/t control on the DM3010 set at maximum, adjust C722 on the OS3600 timebase p.c.b. for two markers/cm to be displayed. The second bright-up should now occur coincident with the 21st available marker. Select the B ONLY mode and apply final adjustment to C722 so that the two B traces coincide. The DM3010 should now read 10.00μs ±12 digits.
10. Set the DM3010 v/t control so that the 11th marker is displayed. (Referring back to the A INTENS BY B position) and align the two B traces. The DM3010 should read 5.00μs ±7 digits.
11. Since the presets C722 and R767 are slightly interactive (by approx ±0.1%) it is best to re-check the

calibration at step 7, readjusting R767 if necessary.

12. Set the A TIME/cm switch back to 1μs/cm again and apply 100ns markers. Select A INTENS BY B (or A ONLY) and pull the x10 switch on the X SHIFT control. Adjust R957 (X x10 GAIN CONTROL) for 1 marker/cm.
13. Set the A TIME/cm switch and the B TIME/cm switch to 50ns. Apply 10ns markers. With the x10 function still selected and the X SHIFT control approximately central, adjust the trimmers C815, C816 for one marker every two centimetres. This is most easily done by firstly setting the trimmers to minimum capacitance and then adjusting each by the same amount of capacitance until the best linearity and accuracy can be obtained.
14. Select the A INTENS BY B position and return the X SHIFT switch to the x1 position. With the same setting as for the previous test, adjust the v/t control on the DM3010 to MINIMUM. Set the DELAY control (OS3600) to align with the leading edge of the first available marker. Pull the x10 control again and select the B ONLY mode. By connecting a small trimmer 0–20pF across the appropriate A.O.T. pins C754 or C755 set the two B traces for alignment. Remove the trimmer measure its value and replace it by a fixed capacitor of nearest preferred tolerance. The B trace alignment should now be within 1ns. This adjustment equalises for differential delay which may exist between the two comparators IC710a and IC710b. Note that if B trace coincidence is already within 1ns no adjustment need be made.
15. Apply 0.5ms markers. Set the A TIME/cm to 1ms and the B TIME/cm to 0.1ms. Select A INTENS BY B and return the x10 switch to the x1 position. Set the DM3010 v/t control to maximum. Adjust the DELAY control (OS3600) to align the first bright-up on the first available marker. Adjust R761 for 2 markers/cm with the second bright-up occuring on the 21st available marker. Now select B ONLY adjust R761 for coincidence of the B traces. The DM3010 should now indicate 10.00ms ±12 digits.
16. Set the DM3010 v/t control to display the 11th marker pulse (using the A INTENS BY B mode). Align the v/t control for coincidence of the B traces on the B ONLY mode and check that the DM3010 reads 5.00ms ±7 digits.
17. Check the DM3010 calibration with the OS3600 oscilloscope on the remaining timebase ranges to be within the specification accuracy. Also check that the full scale indication of the DM3010 is 10 times the A TIME/cm reading.

5.6.2 TIMEBASE – FREQUENCY CALIBRATION

The additional calibration is required for the $\frac{1}{T}$ (FREQUENCY) function. Correct operation of each range should be checked by setting the v/t control for a 1cm delay in the TIME mode and then check each A Timebase range for an equivalent full scale display in the $\frac{I}{T}$ (FREQUENCY) mode. Repeat for 10cm display, checking for the equivalent $\frac{1}{10}$ full scale display.

5.6.3 Y DEFLECTION – VOLTAGE CALIBRATION

1. Select A ONLY, 0.5ms/cm and CH1 display and trigger, AC INPUT COUPLING. Select 'SCOPE' input and volts measurement. Set the CH1 attenuator switch to 10mV/cm.
2. Apply a 100mV calibration signal (1kHz square wave) and set the v/t control on the DM3010 to maximum. Adjust the Y CH1 shift approximately to set the top peaks of the lower (scope Y shift) trace with the bottom peaks of the DM3010 Y-shifted trace approximately in the centre of the c.r.t. display. Adjust R185 so that the top 'SCOPE' Y shift peaks occur on the same horizontal line as the DM3010 bottom peaks (as set by the v/t control). See Fig. 5.2. It is useful to adjust to the horizontal centre line of the graticule to achieve this.
   The DM3010 should now read 100.0mV.
3. Now apply a 50mV calibration signal and re-adjust the DM3010 v/t control for trace coincidence as in step 2. Check that the DM3010 reads 50.0mV ±12 digits.
4. Check all the remaining CH1 VOLTS/cm ranges for calibration accuracy as per step 2 to be within specification noting that the F.S.D. of the DM3010 reads 10 scale divisions in each case.

   NOTE that the dynamic range of the oscilloscope amplifier limits the accuracy at extremes of signal input, i.e. beyond 8cm deflection from the centre. For this reason the above calibration uses a 10cm pk/pk signal a.c. coupled. D.C coupling of a unipolar 10cm signal would cause inaccuracy.

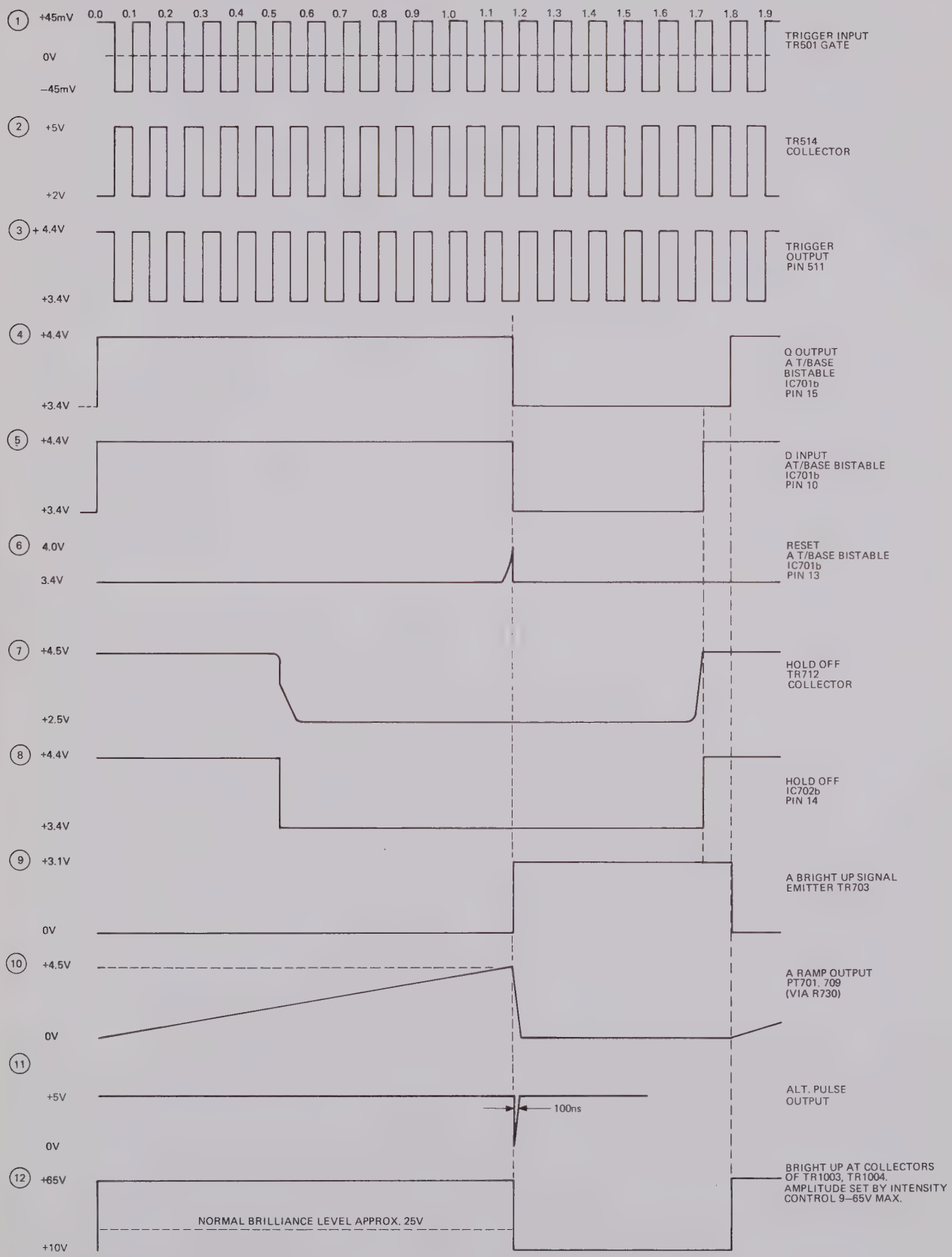


Fig. 2 T/B Waveforms Normal 'A' Sweep

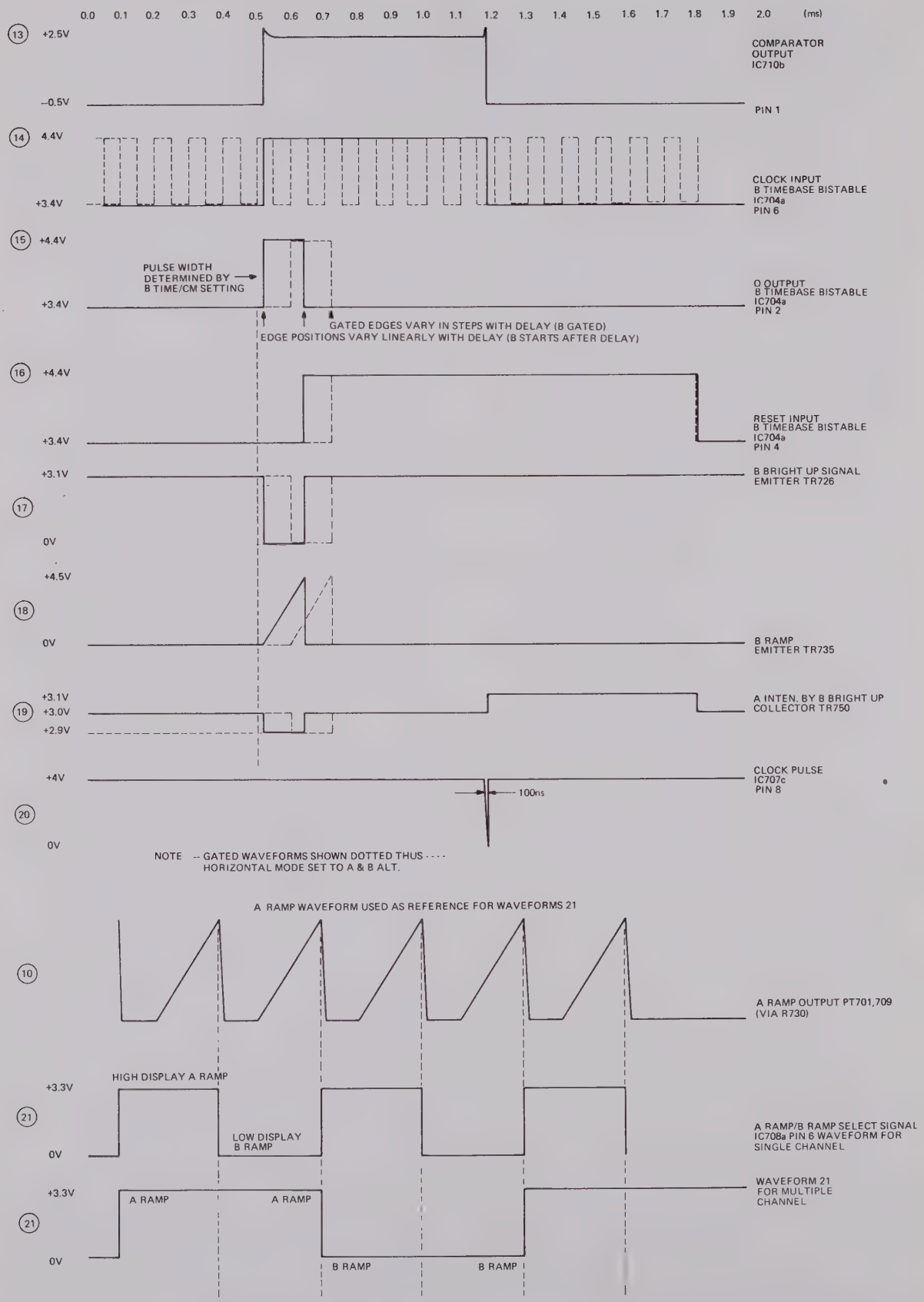


Fig. 3 T/B Waveforms Dual Operation

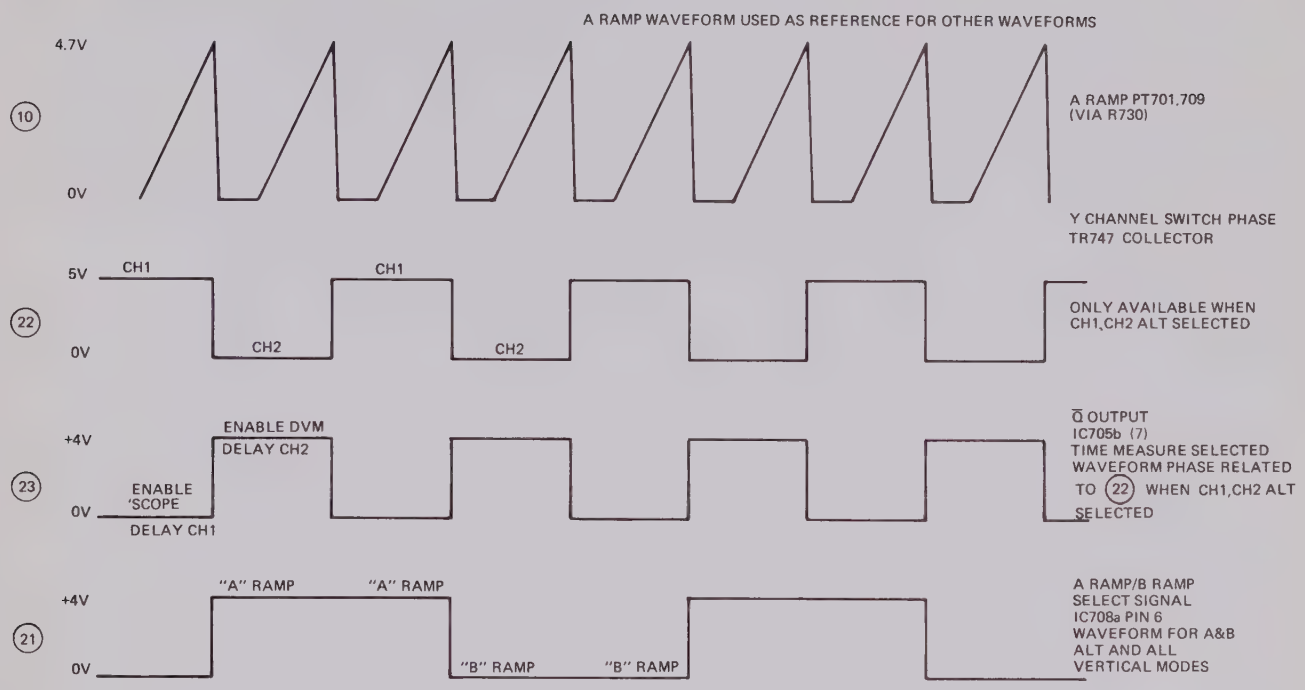


Fig. 4 T/B Waveforms DM3010 Time

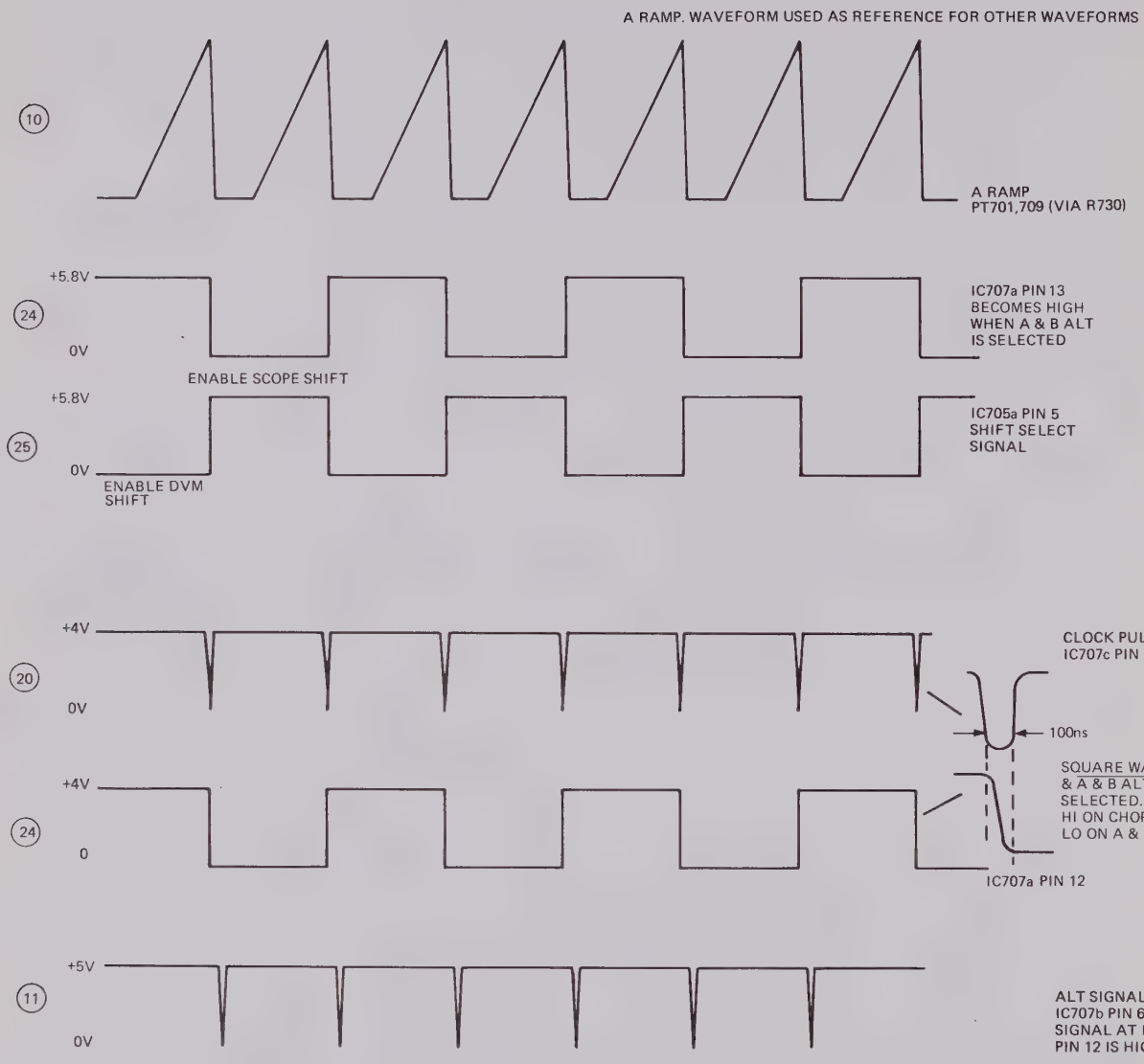


Fig. 5 T/B Waveforms DM3010 Voltage

ABBREVIATIONS USED FOR COMPONENT DESCRIPTIONS

RESISTORS

CC	Carbon Composition	½W	10%	unless otherwise stated
CF	Carbon Film	¼W	5%	unless otherwise stated
MO	Metal Oxide	½W	2%	unless otherwise stated
MF	Metal Film	¼W	2%	unless otherwise stated
MG	Metal Glaze		5%	unless otherwise stated
WW	Wire Wound	6W	5%	unless otherwise stated
CP	Control Potentiometer		20%	unless otherwise stated
PCP	Preset Potentiometer Cermet		20%	unless otherwise stated

CAPACITORS

CE(1)	Ceramic		+40% −20%	unless otherwise stated
CE(2)	Ceramic	500V	±10%	unless otherwise stated
CE(3)	Ceramic	50V	±10%	unless otherwise stated
SM	Silver Mica	350V		
PF	Plastic Film		±10%	unless otherwise stated
PS	Polystyrene	63V	±2½%	unless otherwise stated
PE	Polyester		±10%	unless otherwise stated
PC	Polycarbonate			
E	Electrolytic (aluminium)		+50% −10%	unless otherwise stated
T	Electrolytic (solid tantalum)		+50% −10%	unless otherwise stated
FT	Foil Trimmer			unless otherwise stated

OS3600 TRIGGER

Ref	Value	Description	Tol %±	Part No
RESISTORS				
R15	1.1k	MF	0.5 1/8W	41784
R23	27	CF		28711
R24	27	CF		28711
R25	22	CF		28710
R26	22	CF		28710
R501	390k	MF		38656
R502	100	CF		21794
R503	560	CF		21798
R504	390	MF		38584
R505	390	MF		38584
R506	560	CF		21798
R507	6k8	CF		21807
R508	820	CF		28724
R509	1k5	MF		38598
R510	2k	MF		38601
R511	910	MF		38593
R512	500	PCP		39232
R513	6k8	MF		38614
R514	12k	MF		38620
R515	120	CF		28718
R516	82	CF		28717
R517	1k8	CF		28725
R518	100k	CF		21819
R519	10	CF		21793
R520	20k	PCP		39235
R521	5k6	CF		21806
R522	22k	CP	"A" Trig Level	38676
R523	4k7	CF		21805
R524	100	CF		21794
R525	3k3	CF		21803
R526	1k	MF		38594
R527	680	CF		28723
R528	62	MF		38565
R529	47	CF		28714
R530	47	CF		28714
R531	180	MF		38576
R532	180	MF		38576
R533	820	CF		28724
R534	560	CF		21798
R535	10k	CF		21809
R536	10	CF		21793
R537	10	CF		21793
R538	56	CF		28715
R539	56	CF		28715
R540	39	CF		28713
R541	39	CF		28713
R542	680	CF		28723
R543	820	CF		28724
R544	270	CF		28720
R545	270	CF		28720
R546	47	CF		28714
R547	2k2	CF		21802
R548	68	CF		28716
R549	68	CF		28716
R550	150	CF		28719
R551	150	CF		28719
R552	3k3	CF		21803
R553	10	CF		21793
R554	3k3	CF		21803
R555	10	CF		21793
R556	22	CF		28710
R557	100	CF		21794
R558	22	CF		28710
R559	22	CF		28710
R560	10	CF		21793
R561	1k	CF		21799
R562	27	CF		28711
R563	27	CF		28711
R564	270	CF		28720
R565	270	CF		28720
R566	2k2	CF		21802
R567	390	CF		28722
R568	47	CF		28714
R569	330	CF		28721
R570	330	CF		28721
R571	330	CF		28721
R572	300	CF		38581
R573	560	CF		21798
R574	1k5	MF		38598
R575	1k2	MF		38596
R576	390	MF		38584
R577	330	CF		28721
R578	47	CF		28714
R579	47	CF		28714
R580	430	MF		38585
R581	10	CF		21793
R582	47k	CF		21815
R583	12k	CF		21810
R584	68k	CF		21816
R585	560k	CF		32359
R586	270	CF		28720
R587	470	CF		21797
R588	100k	CF		21819
R589	10k	CF		21809
R590	56	CF		28715
R591	1k5	CF		21801
R592	8k2	CF		21808
R593	270	CF		28720
R594	3k9	CF		21804
R595	2k2	CF		21802
R596	680	CF		28723
R597	10	CF		21793
R598	220k	CF		21823
R599	47	CF		28714
R600				
R601	390k	MF		38656
R602	100	CF		21794
R603	390	MF		38584

OS3600 TRIGGER (Cont)

Ref	Value	Description	Tol %±	Part No
RESISTORS (Cont)				
R604	220	CF		21796
R605	560	CF		21798
R606	390	MF		38584
R607	3k3	CF		21803
R608	3k3	CF		21803
R609	20k	PCP		39235
R610	5k6	CF		21806
R611	4k7	CF		21805
R612	22k	CP	"B" Trig Level (With S516)	38677
R613	100	CF		21794
R614	56	CF		28715
R615	56	CF		28715
R616	1k	CF		21799
R617	62	MF		38565
R618	330	CF		28721
R619	180	MF		38576
R620	180	MF		38576
R621	820	CF		28724
R622	100	CF		21794
R623	100	CF		21794
R624	10	CF		21793
R625	56	CF		28715
R626	56	CF		28715
R627	270	CF		28720
R628	270	CF		28720
R629	39	CF		28713
R630	39	CF		28713
R631	680	CF		28723
R632	22	CF		28710
R633	22	CF		28710
R634	270	CF		28720
R635	27	CF		28711
R636	27	CF		28711
R637	270	CF		28720
R638	1k	CF		21799
R639	10	CF		21793
R640	22	CF		28710
R641	2k2	CF		21802
R642	390	CF		28722
R643	47	CF		28714
R644	330	CF		28721
R645	330	CF		28721
R646	330	CF		28721
R647	300	MF		38581
R648	560	CF		21798
R649	390	MF		38584
R650	1k5	MF		38598
R651	1k2	MF		38596
R652	10	CF		21793
R653	10	CF		21793
R654	330	CF		28721
R655	47	CF		28714
R656	10	CF		21793
R657	47k	CP	Hold Off	38674
R658	100	CF		21794
R659				
R660	43k	MF		38633
R661	300k	MF		38653
R662	39	CF		28713
R663				
R664	3k3	CF		21803
R665	3k3	CF		21803
R671	39	CF		28713
R672	300k	MF		38653
R673	43k	MF		38633
R674	300k	MF		38653
R675	360k	MF		38655
R676	360k	MF		38655
R677	300k	MF		38653
CAPACITORS				
C501	.01µF	CE(1)	250V	22395
C502	.01µF	CE(1)	250V	22395
C503	.01µF	CE(1)	250V	22395
C504	.01µF	CE(1)	250V	22395
C505	.01µF	CE(1)	250V	22395
C506	82pF	PS A.O.T.	63V	37685
C507	.01µF	CE(1)	250V	22395
C508	10pF	CE(2)		22364
C509	15pF	CE(2)		22366
C510	220pF	CE(2)		22379
C511	.01µF	CE(1)	250V	22395
C512	1000pF	CE(2)		22387
C513	.01µF	CE(1)	250V	22395
C514	82pF	CE(2)		22375
C515	.01µF	CE(1)	250V	22395
C516	33pF	CE(2)		22370
C517	.01µF	CE(2)	250V	22395
C518	39pF	CE(2)		22371
C519	.01µF	CE(1)	250V	22395
C520	.01µF	CE(1)	250V	22395
C521	22pF	CE(2)		22368
C522	15pF	CE(2)		22366
C523	.01µF	CE(1)	250V	22395
C524	.01µF	CE(1)	250V	22395
C525	.01µF	CE(1)	250V	22395
C526	.01µF	CE(1)	250V	22395
C527	5600pF	CE(1)	500V	22394
C528	10µF	E	25V	32180
C529	10µF	E	25V	32180
C530	.01µF	CE(2)	250V	22395
C531	.1µF	PE	100V	37018
C532	.1µF	PE	100V	37018
C533	120pF	CE(2)		22377
C534	.01µF	CE(1)	250V	22395
C535	270pF	CE(2)		22380
C536	.01µF	CE(1)	250V	22395
C537	.01µF	CE(1)	250V	22395
C538	.01µF	CE(1)	250V	22395

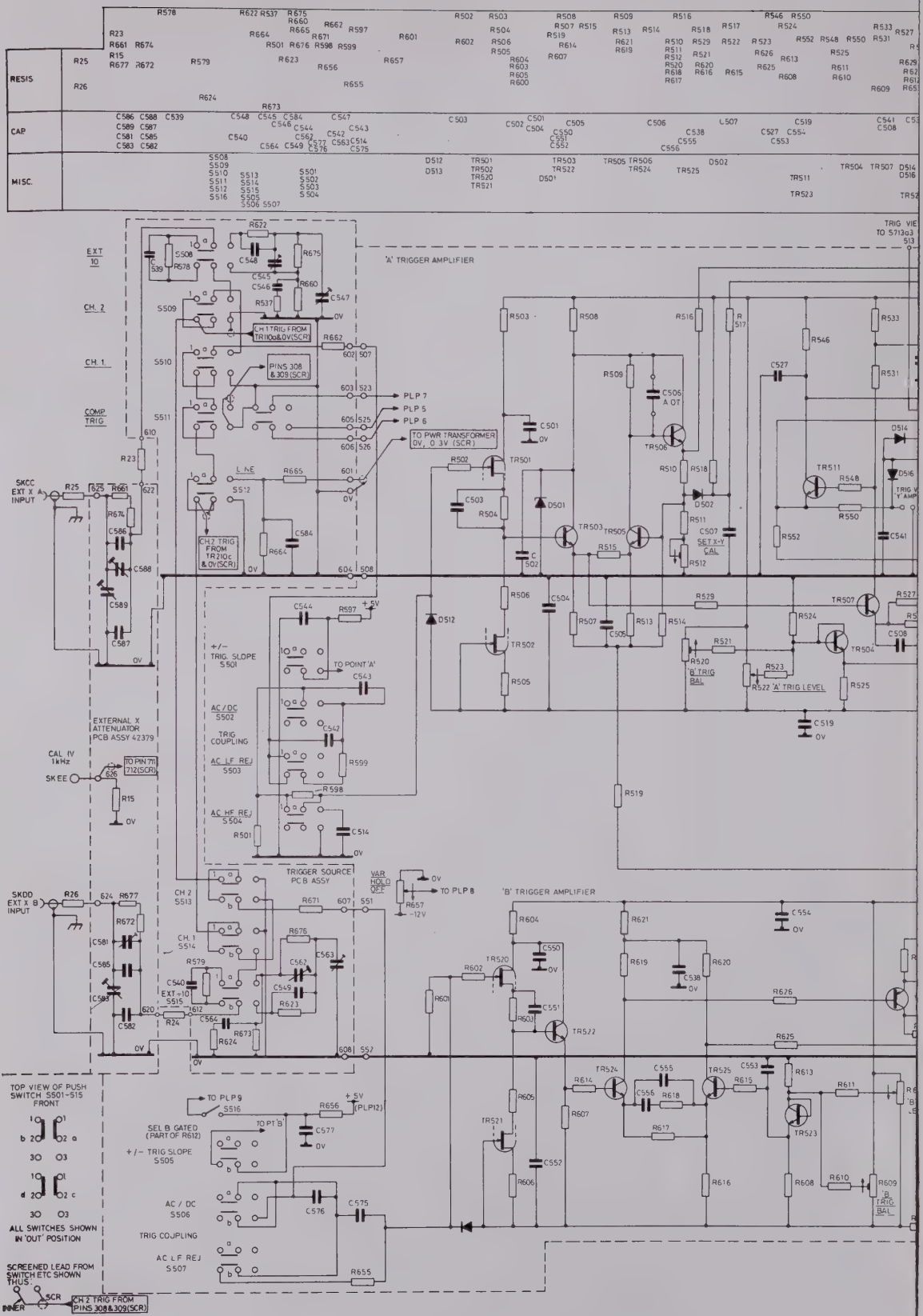
OS3600 TRIGGER (Cont)

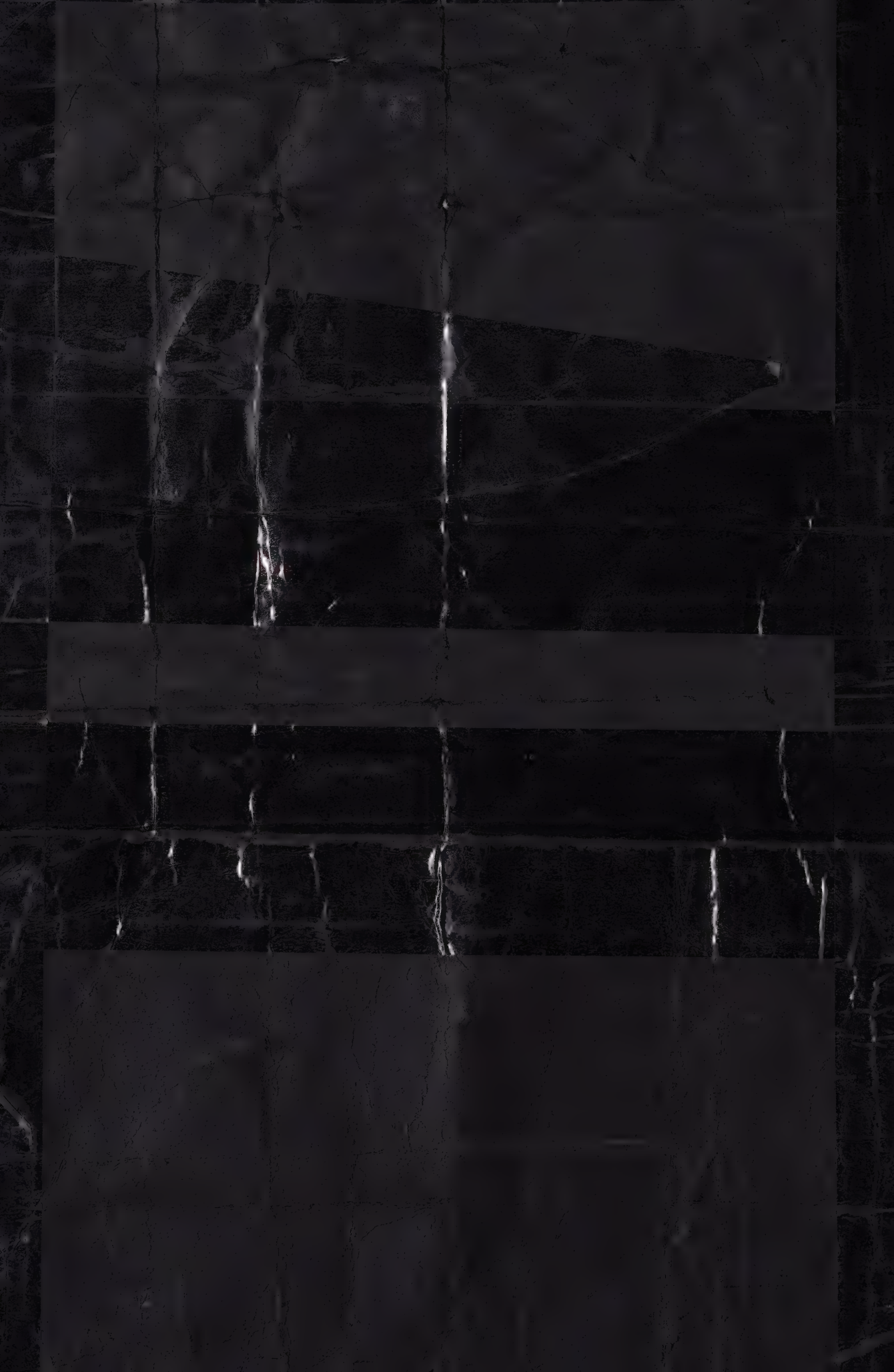
Ref	Value	Description	Tol %±	Part No
CAPACITORS (Cont)				
C539	47pF	CE(2)		22372
C540				
C541	5600pF	CE(1)	500V	22394
C542	100pF	CE(2)		22376
C543	0.1μF	CE(1)	250V	39199
C544	.01μF	CE(1)	250V	22395
C545	15pF	TRIMMER		32059
C546	56pF	CE(2)		22373
C547	15pF	TRIMMER		32059
C548	15pF	CE(2)		23366
C549	15pF	CE(2)		22366
C550	.01μF	CE(1)	250V	22395
C551	.01μF	CE(1)	250V	22395
C552	.01μF	CE(1)	250V	22395
C553	220pF	CE(2)		22379
C554	.01μF	CE(1)	250V	22395
C555	33pF	CE(2)		22370
C556	15pF	CE(2)		22366
C557	.01μF	CE(1)	250V	22395
C558	39pF	CE(2)		22371
C559	.01μF	CE(1)	250V	22395
C560	33pF	CE(2)		22370
C561	.01μF	CE(1)	250V	22395
C562	15pF	TRIMMER		32059
C563	15pF	TRIMMER		32059
C564	56pF	CE(2)		22373
C565	.01μF	CE(1)	250V	22395
C566	22pF	CE(2)		22368
C567	15pF	CE(2)		22366
C568	.01μF	CE(1)	250V	22395
C569	.01μF	CE(1)	250V	22395
C570	.01μF	CE(1)	250V	22395
C571	.01μF	CE(1)	250V	22395
C572	10μF	E	10V	40353
C573				
C574				
C575	100pF	CE(2)		22376
C576	0.1μF	CE(1)	250V	39199
C577	.01μF	CE(1)	250V	22395
C581	15pF	TRIMMER		32059
C582	15pF	CE(2)		22366
C583	6pF	TRIMMER		29421
C584	0.01	CE(1)	250V	22395
C585	22pF	CE(2)		22368
C586	22pF	CE(2)		22368
C587	10pF	CE(2)		22364
C588	15pF	TRIMMER		32059
C589	6pF	TRIMMER		29421
TRANSISTORS				
TR501, TR502		WD392	Dual f.e.t.	A36343
TR503, TR504		AE13	Matched pair	A31254

Ref	Value	Description	Tol %±	Part No
TRANSISTORS (Cont)				
TR505		2N3904		24146
TR506		2N3904		24146
TR507		MPSH10		40315
TR508		MPSH10		40315
TR509		BF479		39270
TR510		BF479		39270
TR511		MPSH10		40315
TR512		MPSH10		40315
TR513		MPSH10		40315
TR514		MPSH10		40315
TR515		MPSH10		40315
TR516		2N5771		38089
TR517		MPSH10		40315
TR518		BC182B		33205
TR519				
TR520, TR521		WD392	Dual f.e.t.	A36243
TR522, TR523		AE13	Matched pair	A31254
TR524		MPSH10		40315
TR525		MPSH10		40315
TR526		BF479		39270
TR527		BF479		39270
TR528		MPSH10		40315
TR529		MPSH10		40315
DIODES				
D15		L.E.D.		39884
D501	5V1	ZENER		33923
D502		IN4148		23802
D503	3V3	ZENER		33923
D504	9V1	ZENER		33934
D505	6V2	ZENER		33930
D506		IN4148		23802
D507		IN4148		23802
D508		IN4149		1949
D509		IN4149		1949
D510		IN4148		23802
D511		IN4148		23802
D512		IN3595		29330
D513		IN3595		29330
D514		IN4148		23802
D515	9V1	ZENER		33934
INTEGRATED CIRCUITS				
IC501		10216		33903
IC502		10216		33903
MISCELLANEOUS				
S501-504		Switch Push Button A Coupling		A3/40738
S505-507		Switch Push Button B Coupling		A3/40737
S508-512		Switch A Trigger Source		A3/41672
S513-515		Switch B Trigger Source		A3/42268

OS3600 TRIGGER (Cont)

Ref	Value	Description	Tol %±	Part No	Ref	Value	Description	Tol %±	Part No
MISCELLANEOUS (Cont)									
S516		Switch Select B Gated			PLR		Plug Molex 3-Way LKG		39222
		Part of R612		38677					
					SKCC		Socket BNC	Ext. X A Input	1222
PLP		Plug Molex 14-Way		38297	SKDD		Socket BNC	Ext X B Input	1222


RESIS.
CAP.
MISC.
'A' TRIGGER AMPLIFIER
'B' TRIGGER AMPLIFIER
TRIGGER SOURCE PCB ASSY
EXTERNAL X ATTENUATOR PCB ASSY 42379
EXT 10
CH. 2
CH. 1
COMP. TRIG
SKCC EXT X A INPUT
SKDD EXT X B INPUT
CAL IV 1kHz
SKEE
+/- TRIG. SLOPE S501
AC/DC S502
TRIG COUPLING
AC LF REJ S503
AC HF REJ S504
TO POINT 'A'
TO PLP 7
TO PLP 5
TO PLP 6
TO PWR TRANSFORMER 0V, 0 3V (SCR)
PINS 308 & 309 (SCR)
CH 1 TRIG FROM TR110 & 0V (SCR)
CH 2 TRIG FROM TR210 & 0V (SCR)
A TRIG BAL
'A' TRIG LEVEL
SET X-Y CAL
B TRIG BAL
VAR HOLD OFF
TO PLP 8
TO PLP 9
SEL B GATED (PART OF R612)
TO PT 'B'
AC / DC S506
TRIG COUPLING
AC LF REJ S507
TOP VIEW OF PUSH SWITCH S501-515 FRONT
ALL SWITCHES SHOWN IN 'OUT' POSITION
SCREENED LEAD FROM SWITCH ETC SHOWN THUS
INNER
SCR
CH 2 TRIG FROM PINS 308 & 309 (SCR)
TRIG VIE TO S713 g3



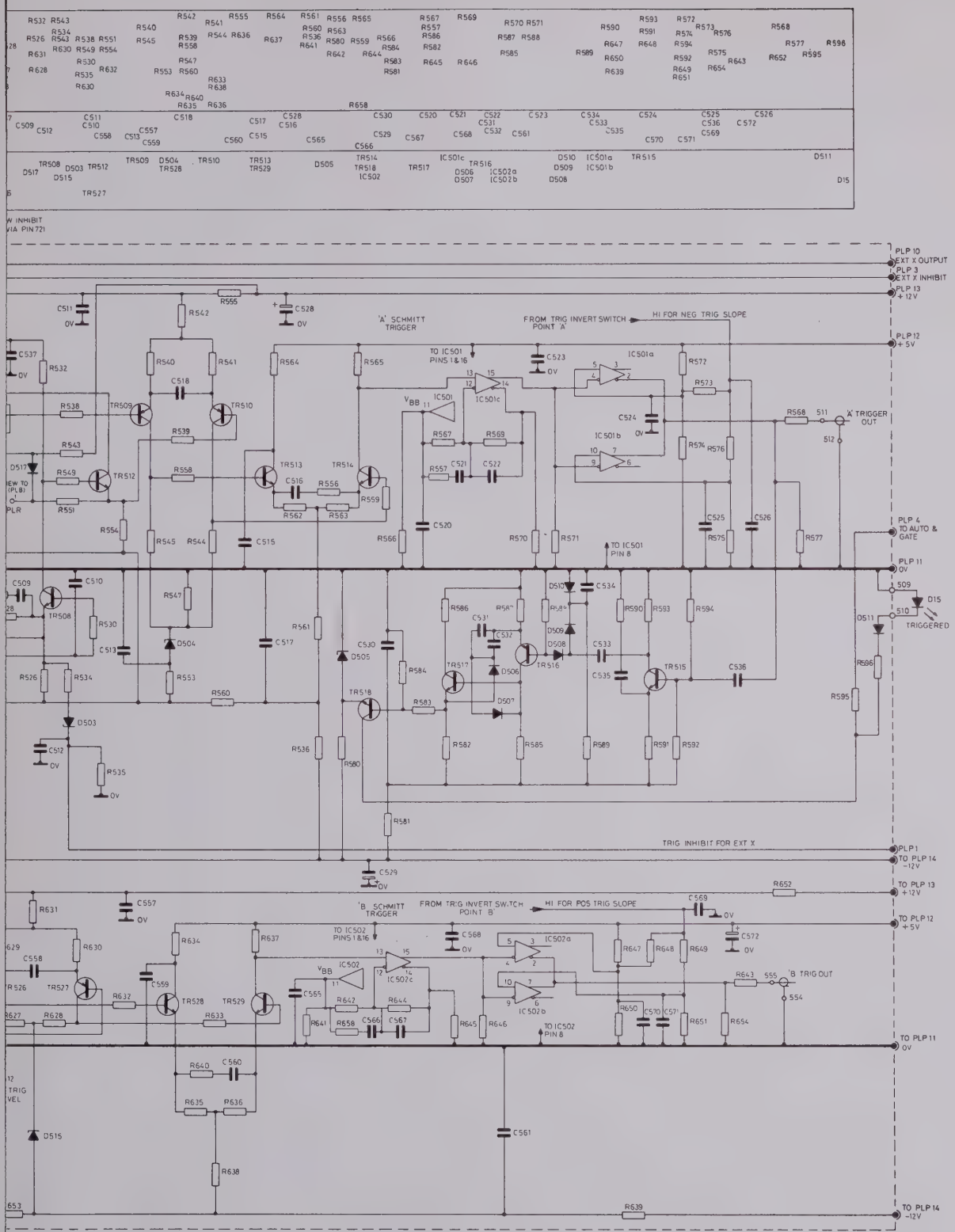
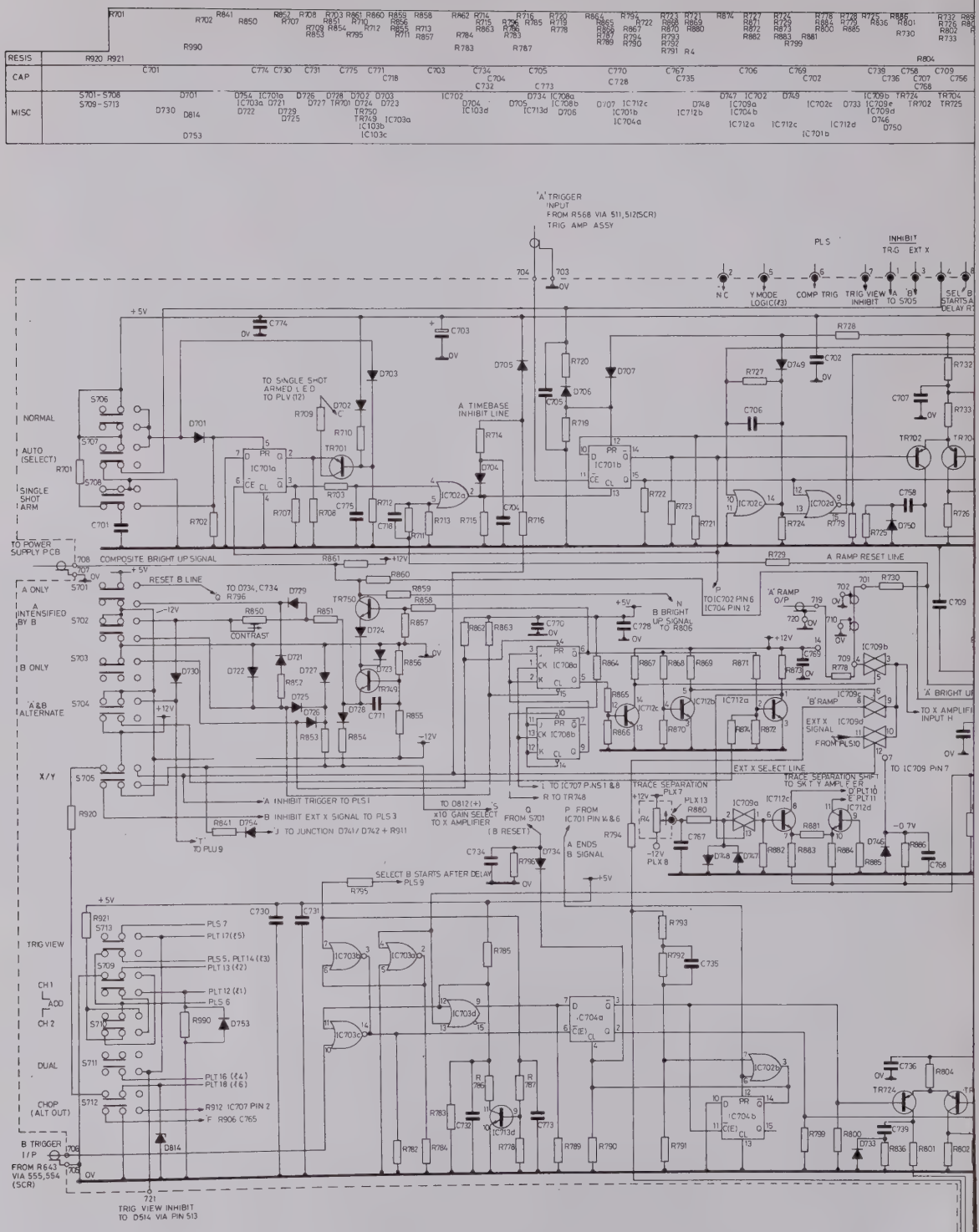

'A' SCHMITT TRIGGER
FROM TRIG INVERT SWITCH POINT 'A'
HI FOR NEG TRIG SLOPE
TO IC501 PINS 1&16
TO IC501 PIN 8
'A' TRIGGER OUT
TRIGGERED
TRIG INHIBIT FOR EXT X
'B' SCHMITT TRIGGER
FROM TRIG INVERT SWITCH POINT 'B'
HI FOR POS TRIG SLOPE
TO IC502 PINS 1&16
TO IC502 PIN 8
'B' TRIG OUT
PLP 10 EXT X OUTPUT
PLP 3 EXT X INHIBIT
PLP 13 +12V
PLP 12 +5V
PLP 4 TO AUTO & GATE
PLP 11 0V
PLP 1
TO PLP 14 -12V
TO PLP 13 +12V
TO PLP 12 +5V
TO PLP 11 0V
TO PLP 14 -12V

Fig. 6 Trigger Circuit Diagram

OS3600 TIMEBASE, 'X' O/P & CALIBRATOR

Ref	Value	Description	Tol %±	Part No
RESISTORS				
R701	10k	CF		21809
R702	2k2	CF		21802
R703	180	CF		21795
R704				
R705				
R706				
R707	2k2	CF		21802
R708	4k7	CF		21805
R709	270	CF		28720
R710	1k2	MF		38596
R711	470	CF		21797
R712	3k3	MF		38606
R713	3k9	CF		21804
R714	100	CF		21794
R715	2k2	CF		21802
R716	1k5	CF		21801
R717				
R718				
R719	2k7	CF		28726
R720	390	CF		28722
R721	1k	CF		21799
R722	680	CF		28723
R723	680	CF		28723
R724	1k	CF		21799
R725	1k2	CF		21800
R726	360	MF		38583
R727	1k5	CF		21801
R728	3k3	CF		21803
R729	220	CF		21796
R730	10	CF		21793
R731	100	CF		21794
R732	10	CF		21793
R733	820	MF		38592
R734	1k5	CF		21801
R735	6k8	CF		21807
R736	470	CF		21797
R737	150k	MF		38646
R738	10k	CF		21809
R739	3k3	CF		21803
R740	1k5	CF		21801
R741	270k	CF		32356
R742	8k2	CF		21808
R743	10k	CF		21809
R744	10k	CF		21809
R745	220k	MF		38650
R746	15k	CF		28727
R747	15k	CF		28727
R748	470	CF		21797
R749	510	MF		38587
R750	10	CF		21793
R751	560	CF		21798
R752	220	CF		21796
R753	1k5	CF		21801
R754	1k5	CF		21801
R755	8k2	CF		21808
R756	12k	CF		21810
R757	33k	CF		21814
R758	470k	CF		32330
R759	470k	CF		32330
R760	22k	CF		21812
R761	5k	PCP		39234
R762	10k	CF		21809
R763	56	CF		28715
R764	68k	CF		21816
R765	18k	MF		38624
R766	9k1	MF		38617
R767	50k	PCP		39268
R768	5k6	CF		21806
R769	39k	CF		28728
R770	2k7	CF		28726
R771	910	MF		38593
R772	2k7	CF		28726
R773	390	CF		28722
R774	47	CF		28714
R775	47	CF		28714
R776	47	CF		28714
R777	15	CF		28708
R778	10k	CF		21809
R779	1k2	CF		21800
R780	39k	CF		28728
R781	33k	CF		21814
R782	390	CF		28722
R783	3k9	CF		21804
R784	1k	CF		21799
R785	470	CF		21797
R786	680	CF		28723
R787	2k7	CF		28726
R788	8k2	CF		21808
R789	1k	CF		21799
R790	2k2	CF		21802
R791	3k9	CF		21804
R792	470	CF		21797
R793	220	CF		21796
R794	39	CF		28713
R795	470	CF		21797
R796	10k	CF		21809
R797				
R798	15	CF		28708
R799	1k	CF		21799
R800	1k	CF		21799
R801	390	CF		28722
R802	360	MF		38583
R803	6k8	CF		21807
R804	820	MF		38592
R805	10	CF		21793
R806	2k7	CF		28726
R807	10	CF		21793
R808	1k8	CF		28725
R809	510	MF		38587
R810	560	CF		21798

RESISTORS (Cont)


RESIS
CAP
MISC
'A' TRIGGER INPUT FROM R568 VIA 511,512(SCR) TRIG AMP ASSY
INHIBIT TRIG EXT X
N/C
Y MODE LOGIC(#3)
COMP TRIG
TRIG VIEW INHIBIT
A B TO S705
SEL B STARTS A DELAY R7
+5V
0V
NORMAL
AUTO (SELECT)
SINGLE SHOT ARM
TO SINGLE SHOT ARMED LED TO PLV (12)
A TIMEBASE INHIBIT LINE
TO POWER SUPPLY PCB
COMPOSITE BRIGHT UP SIGNAL
RESET B LINE
A ONLY
A INTENSIFIED BY B
B ONLY
A&B ALTERNATE
X/Y
CONTRAST
+12V
-12V
A RAMP RESET LINE
TO IC702 PIN 6 IC704 PIN 12
B BRIGHT UP SIGNAL TO R806
'A' RAMP O/P
'B' RAMP
EXT X SIGNAL FROM PL510
EXT X SELECT LINE
TRACE SEPARATION PLX 7
TRACE SEPARATION SHIFT TO SKT Y AMPLIFIER
TO X AMPLIFIER INPUT H
A INHIBIT TRIGGER TO PLS 1
B INHIBIT EXT X SIGNAL TO PLS 3
TO JUNCTION D741/ D742 + R911
TO PLU 9
TO D812 (+) x10 GAIN SELECT TO X AMPLIFIER
P FROM IC701 PIN 14 & 6
A ENDS B SIGNAL
(B RESET)
SELECT B STARTS AFTER DELAY
TRIG VIEW
CH 1 ADD CH 2
DUAL
CHOP (ALT OUT)
B TRIGGER I/P
FROM R643 VIA 555,554 (SCR)
TRIG VIEW INHIBIT TO D514 VIA PIN 513

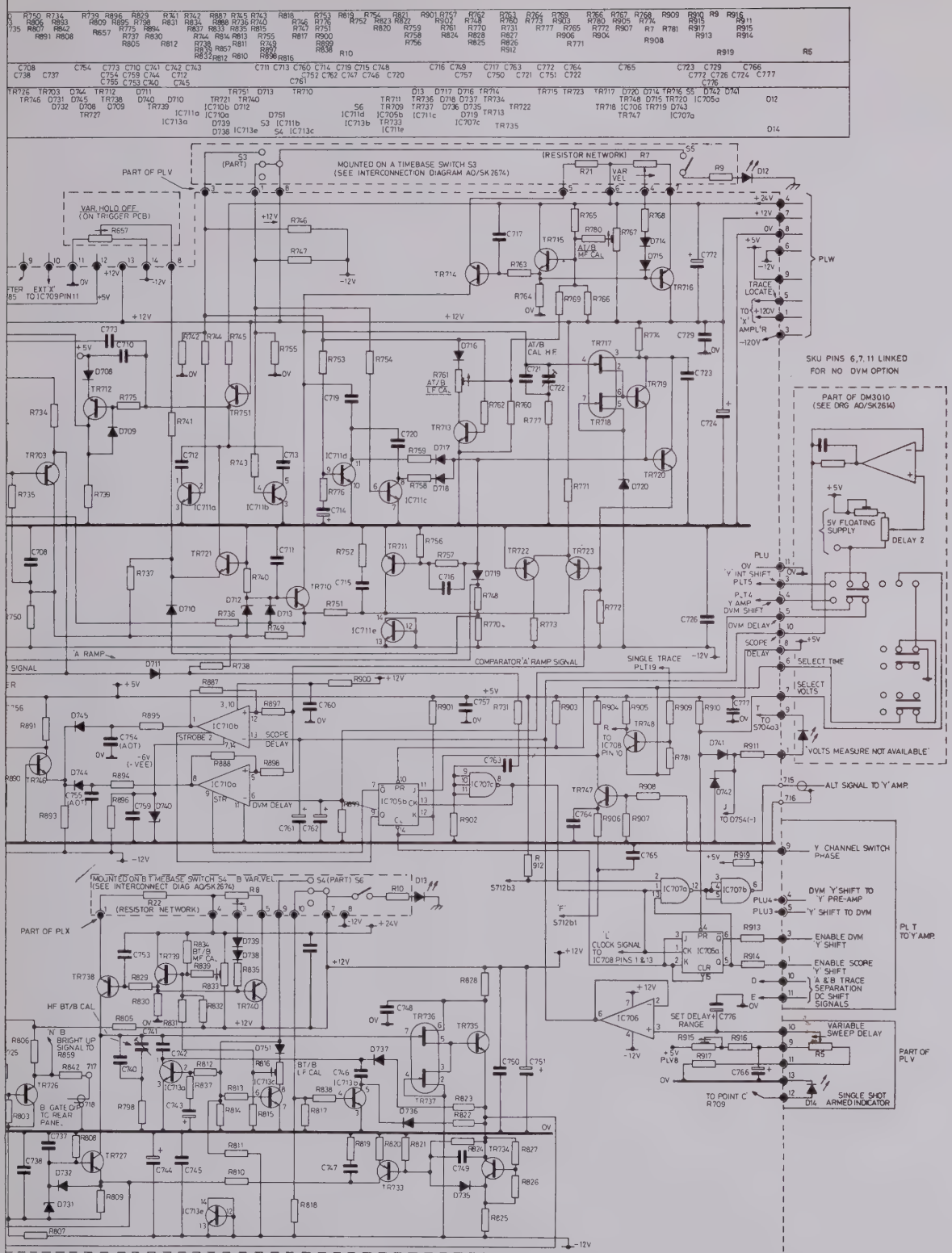


Fig. 7A Timebase 'X' O/P & Calibrator Circuit Diagram

OS3600 TIMEBASE, 'X' O/P & CALIBRATOR (Cont)

Ref	Value	Description	Tol %±	Part No
RESISTORS (Cont)				
R811	15k	CF		28727
R812	1k5	CF		21801
R813	10k	CF		21809
R814	8k2	CF		21808
R815	22k	CF		21812
R816	5k	PCP		39234
R817	8k2	CF		21808
R818	15k	CF		28727
R819	220	CF		21796
R820	4R7	CF		29433
R821	12k	CF		21810
R822	470k	CF		32330
R823	470k	CF		32330
R824	33k	CF		21814
R825	3k3	CF		21803
R826	470	CF		21797
R827	430	MF		38585
R828	100	CF		21794
R829	56	CF		28715
R830	68k	CF		21816
R831	39k	CF		28728
R832	9k1	MF		38617
R833	50k	PCP		39268
R834	18k	MF		38624
R835	5k6	CF		21806
R836	1k2	CF		21800
R837	47	CF		28714
R838	1k5	CF		21801
R839	39k	CF		28728
R840				
R841	5k6	CF		21806
R842	10k	CF		21809
R850	10k	PCP		39265
R851	4k3	MF		38609
R852	5k6	CF		21806
R853	3k9	CF		21804
R854	2k2	CF		21802
R855	10k	CF		21809
R856	2k2	CF		21802
R857	2k2	CF		21802
R858	2k2	CF		21802
R859	1k5	CF		21801
R860	1k5	CF		21801
R861	4k7	CF		21805
R862	4k7	CF		21805
R863	4k7	CF		21805
R864	4k7	CF		21805
R865	6k8	CF		21807
R866	6k8	CF		21807
R867	4k7	CF		21805
R868	6k8	CF		21807
R869	4k7	CF		21805
R870	6k8	CF		21807
R871	6k8	CF		21807
R872	6k8	CF		21807
R873	4k7	CF		21805
R874	12k	CF		21810
R880	6k8	CF		21807
R881	120	CF		28718
R882	100	CF		21794
R883	12k	CF		21810
R884	12k	CF		21810
R885	100	CF		21794
R886	5k6	CF		21806
R887	47k	CF		21815
R888	47k	CF		21815
R889				
R890	3k9	CF		21804
R891	470	CF		21797
R892				
R893	3k3	CF		21803
R894	390	CF		28722
R895	390	CF		28722
R896	560	CF		21798
R897	47	CF		28714
R898	47	CF		28714
R899	47k	CF		21815
R900	10	CF		21793
R901	4k7	CF		21805
R902	1k	CF		21799
R903	4k7	CF		21805
R904	4k7	CF		21805
R905	4k7	CF		21805
R906	10	CF		21793
R907	6k8	CF		21807
R908	6k8	CF		21807
R909	56k	CF		28729
R910	4k7	CF		21805
R911	2k2	CF		21802
R912	10k	CF		21809
R913	100	CF		21794
R914	100	CF		21794
R915	1k	PCP		39233
R916	680	CF		28723
R917	100	CF		21794
R918				
R919	4k7	CF		21805
R920	3k3	CF		21803
R921	1k	CF		21799
R922				
R928	270	CF		28720
R929	22	CF		28710
R930	1k	CF		21799
R931	620	MF		38589
R932	47	CF		28714
R933	220	CF		21796
R934	220	CF		21796

OS3600 TIMEBASE, 'X' O/P & CALIBRATOR (Cont)

Ref	Value	Description	Tol %±		Part No
RESISTORS (Cont)					
R935	150k	MF			38646
R936	150k	MF			38646
R937	36k	MO			28811
R938	36k	MO			28811
R939	68	CF			28716
R940	680	CF			28723
R941	330	CF			28721
R942	560	CF			21798
R943	68	CF			28716
R944	36k	MO			28811
R945	10	CF			21793
R946	470	CF			21797
R947	47	CF			28714
R948	6k8	CF			21807
R949	6k8	CF			21807
R950	10	CF			21793
R951	33k	MF			38630
R952	51k	MF			38635
R953	22	CF			28710
R954	10k	MF			38618
R955	10k	MF			38618
R956	470	CF			21797
R957	1k	PCP			39233
R958	220	CF			21796
R959	220	CF			21796
R960	10k	PCP			39265
R961	5k6	CF			21806
R962	2k2	MF			38602
R963	2k2	MF			38602
R964	4k7	CF			21805
R965	2k2	CF			21802
R966	56k	CF			28729
R967	5k6	CF			21806
R968	36k	MF			38631
R969	1k6	MF			38599
R970	12k	MF			38620
R971	10k	CF		A.O.T.	21809
R972	4k7	CF		A.O.T.	21805
R973	750	MF			38591
R974	5k6	MF			38612
R975	11k	MF			38619
R976	30k	MF			38629
R977	10	CF			21793
R978	3k9	CF			21804
R979	22	CF			28710
R980	220	CF			21796
R981	220	CF			21796
R982	680	CF			28723
R983	9k1	MF			38617
R984	3k3	CF			21803
R985	10k1	MF	0.5	1/8W	37778
R986					
R987	1k3	MF			38597
R988	100	CF			21794
R989	100	CF			21794
R990	10k	CF			21809

Ref	Value	Description	Tol %±	Part No
CAPACITORS				
C701	1000pF	CE(2)		22387
C702	.01μF	CE(1)	250V	22395
C703	10μF	E	10V	40353
C704	.01μF	CE(1)	250V	22395
C705	.01μF	CE(1)	250V	22395
C706	33pF	CE(2)		22370
C707	0.01μF	CE(1)	250V	22395
C708	.01μF	CE(1)	250V	22395
C709	1μF	T	35V	34895
C710	47pF	CE(2)		22372
C711	.01μF	CE(1)	250V	22395
C712	1μF	PE	100V	37389
C713	.01μF	PE	100V	39190
C714	10μF	E	10V	40353
C715	220pF	CE(2)		22379
C716	56pF	CE(2)		22373
C717	.1μF	PE	100V	37018
C718	68pF	CE(2)		22374
C719	2.2μF	PC		40853
C720	.022μF	PC		40854
C721	180pF	SM	½pF	4515
C722	45pF	FT		36274
C723	.01μF	CE(1)	250V	22395
C724	10μF	E	25V	32180
C725				
C726	.01μF	CE(1)	250V	22395
C727				
C728	.01μF	CE(1)	250V	22395
C729	.01μF	CE(1)	250V	22395
C730	.01μF	CE(1)	250V	22395
C731	.01μF	CE(1)	250V	22395
C732	.01μF	CE(1)	250V	22395
C733	.01μF	CE(1)	250V	22395
C734	.01μF	CE(1)	250V	22395
C735	68pF	CE(2)		22374
C736	.01μF	CE(1)	250V	22395
C737	.01μF	CE(1)	250V	22395
C738	.01μF	CE(1)	250V	22395
C739	56pF	CE(2)		22373
C740	180pF	SM	½pF	4515
C741	45pF	FT		36274
C742	2.2μF	PC		40853
C743	10μF	E	10V	40353
C744	10μF	E	25V	32180
C745	.01μF	CE(1)	250V	22395
C746	.022μF	PC		40854
C747	220pF	CE(2)		22379
C748	.01μF	CE(1)	250V	22395
C749	56pF	CE(2)		22373
C750	.01μF	CE(1)	250V	22395
C751	10μF	E	25V	32180
C752	.01μF	CE(1)	250V	22395
C753	.1μF	PE	100V	37018
C754				
C755				
C756	10μF	E	10V	40353

OS3600 TIMEBASE, 'X' O/P & CALIBRATOR (Cont)

Ref	Value	Description	Tol %±	Part No
CAPACITORS (Cont)				
C757	.01μF	CE(1)	250V	22395
C758	56pF	CE(2)		22373
C759	.01μF	CE(1)	250V	22395
C760	.01μF	CE(1)	250V	22395
C761	1μF	T	35V	34895
C762	1μF	T	35V	34895
C763	100pF	CE(2)		22376
C764	.01μF	CE(1)	250V	22395
C765	.01μF	CE(1)	250V	22395
C766	10μF	E	25V	32180
C767	.01μF	CE(1)	250V	22395
C768	.01μF	CE(1)	250V	22395
C769	.01μF	CE(1)	250V	22395
C770	.01μF	CE(1)	250V	22395
C771	.01μF	CE(1)	250V	22395
C772	10μF	E	25V	32180
C773	27pF	CE(2)		22369
C774	0.01μF	CE(1)	250V	22395
C775	680pF	CE(2)		22385
C776	22μF	T	16V	54220
C777	.01μF	CE(1)	250V	22395
C801	0.01μF	CE(1)	250V	22395
C802	0.01μF	CE(1)	250V	22395
C803	0.01μF	CE(1)	250V	22395
C804	0.01μF	CE(1)	250V	22395
C805	0.01μF	CE(1)	250V	22395
C806	0.01μF	CE(1)	250V	22395
C807	0.01μF	CE(1)	250V	22395
C808	0.01μF	CE(1)	250V	22395
C809	0.01μF	CE(1)	250V	22395
C810	2.7pF	SM	½pF	816
C811	2.7pF	SM	½pF	816
C812	0.01μF	CE(1)	250V	22395
C813	1.5pF	CE(2)		40356
C814	1.5pF	CE(2)		40356
C815	9pF	FT		36272
C816	9pF	FT		36272
C817	1.5pF	CE(2)		40356
C818	1.5pF	CE(2)		40356
C819	0.01μF	PF		37018
C820	150pF	CE(2)		22378
C821	150pF	CE(2)		22378
C822	0.01μF	CE(1)	250V	22395
C823	0.01μF	CE(1)	250V	22395
C824	0.01μF	CE(1)	250V	22395
C825	10μF	E	25V	32180
C826	0.01μF	CE(1)	250V	22395
C827	0.01μF	CE(1)	250V	22395
C828	0.01μF	CE(1)	250V	22395
C829	100nF	PE		37018
C830	470pF	CE(2)		22383
C831	15pF	CE(2)		22366
C832	0.01μF	CE(1)	250V	22395
C833	0.01μF	CE(1)	250V	22395

Ref	Value	Description	Tol %±	Part No
CAPACITORS (Cont)				
C841	10μF	E	25V	32180
C842	33μF	E	16V	32173
C843	33μF	E	16V	32173
C844	0.15μF	PE	250V	35601
C845	39pF	CE(2)		22371
TRANSISTORS				
TR701		BC212		29327
TR702		2N5771		38089
TR703		2N3906		21533
TR704		2N5771		38089
TR710		BC182	Selected	40349
TR711		2N5771		38089
TR712		BC214C		36019
TR713		2N3904		24146
TR714		BC214C	Selected	40348
TR715		BC182B		33205
TR716		BC212		29327
TR717	}	J412-1	Dual f.e.t.	44703
TR718	}			
TR719		MPS2369		36625
TR720		MPS2369		36625
TR721		2N3904		24146
TR722		ZTX3906		41811
TR723		ZTX3906		41811
TR724		2N5771		38089
TR725		2N5771		38089
TR726		2N3906		21533
TR727		BC182B	Selected	40349
TR733		2N5771		38089
TR734		2N3904		24146
TR735		2N3904		24146
TR736	}	J412-1	Dual f.e.t.	44703
TR737	}			
TR738		BC214C	Selected	40348
TR739		BC182B		33205
TR740		BC212		29327
TR746		MPS2369		36625
TR747		MPS2369		36625
TR748		2N3904		24146
TR749		2N3904		24146
TR750		2N3904		24146
TR751		BC212		29327
TR801		BF470		38416
TR802		BF470		38416
TR803		BF469		38418
TR804		BF469		38418
TR805		2N5771		38089
TR806		2N2369		23307
TR807		2N2369		23307
TR808		2N5771		38089
TR809		BF371		36275

OS3600 TIMEBASE, 'X' O/P & CALIBRATOR (Cont)

Ref	Value	Description	Tol %±	Part No
TRANSISTORS (Cont)				
TR810		BF371		36275
TR811		BF371		36275
TR812		BF371		36275
TR813		2N3904		24146
TR814		2N3904		24146
TR815		2N3904		24146
DIODES				
D701		IN4148		23802
D702		IN4148		23802
D703		IN4148		23802
D704		IN4148		23802
D705		IN4148		23802
D706		IN4148		23802
D707		IN4148		23802
D708		IN4148		23802
D709		IN4148		23802
D710		IN4148		23802
D711		IN4148		23802
D712	3V9	ZENER		33925
D713		IN4148		23802
D714		IN4148		23802
D715		IN4148		23802
D716		IN4148		23802
D717		IN4148		23802
D718		IN4148		23802
D719		IN4148		23802
D720	2V7	ZENER		33921
D721		IN4148		23802
D722		IN4148		23802
D723		IN4148		23802
D724		IN4148		23802
D725		IN4148		23802
D726		IN4148		23802
D727		IN4148		23802
D728		IN4148		23802
D729		IN4148		23802
D730		IN4148		23802
D731	3V9	ZENER		33925
D732		IN4148		23802
D733		IN4148		23802
D734		IN4148		23802
D735		IN4148		23802
D736		IN4148		23802
D737		IN4148		23802
D738		IN4148		23802
D739		IN4148		23802
D740	5V6	ZENER		33929
D741		IN4148		23802
D742		IN4148		23802
D743				
D744		IN4148		23802
D745		IN4148		23802
D746		IN4148		23802
D747		IN4148		23802
D748		IN4148		23802

Ref	Value	Description	Tol %±	Part No
DIODES (Cont)				
D749		IN4148		23802
D750		IN4148		23802
D751		IN4148		23802
D752				
D753		IN4148		23802
D754		IN4148		23802
D801	5V6	ZENER		33929
D802	3V9	ZENER		33925
D803	7V5	ZENER		33932
D804		IN4149		1949
D805		IN4149		1949
D806		IN4149		1949
D807		IN4149		1949
D808		FH1100		40352
D809		FH1100		40352
D810		IN4149		1949
D811		IN4149		1949
D812		IN4148		23802
D813		IN4148		23802
D814	5V1	ZENER		33928
D815	33V	ZENER		33947
D816	33V	ZENER		33947
D821		IN4148		23802
D822		IN4148		23802
INTEGRATED CIRCUITS				
IC701		10231		39247
IC702		10103		40346
IC703		10102		30243
IC704		10231		39247
IC705		74LS112		36468
IC706		741		36736
IC707		74LS10		36867
IC708		74LS112		36468
IC709		CD4066		40345
IC710		1414		35682
IC711		CA3086		42907
IC712		CA3086		42907
IC713		CA3086		42907
IC714		709		40179
MISCELLANEOUS				
S701–705		Switch Pushbutton		A3/40735
S706–708		Switch Pushbutton		A3/40736
S709–713		Switch Pushbutton Y Mode Select		A3/43001
L701		Ferrite Bead FX1242		26986
L702		Ferrite Bead FX1242		26986
PLS		Plug Molex 14 Way		38297
PLT		Plug Molex 19 Way		42502
PLU		Plug Molex 11 Way		40323
PLV		Plug Molex 13 Way		39387
PLW		Plug Molex 9 Way		39386
PLX		Plug Molex 13 Way		39287

| | | |

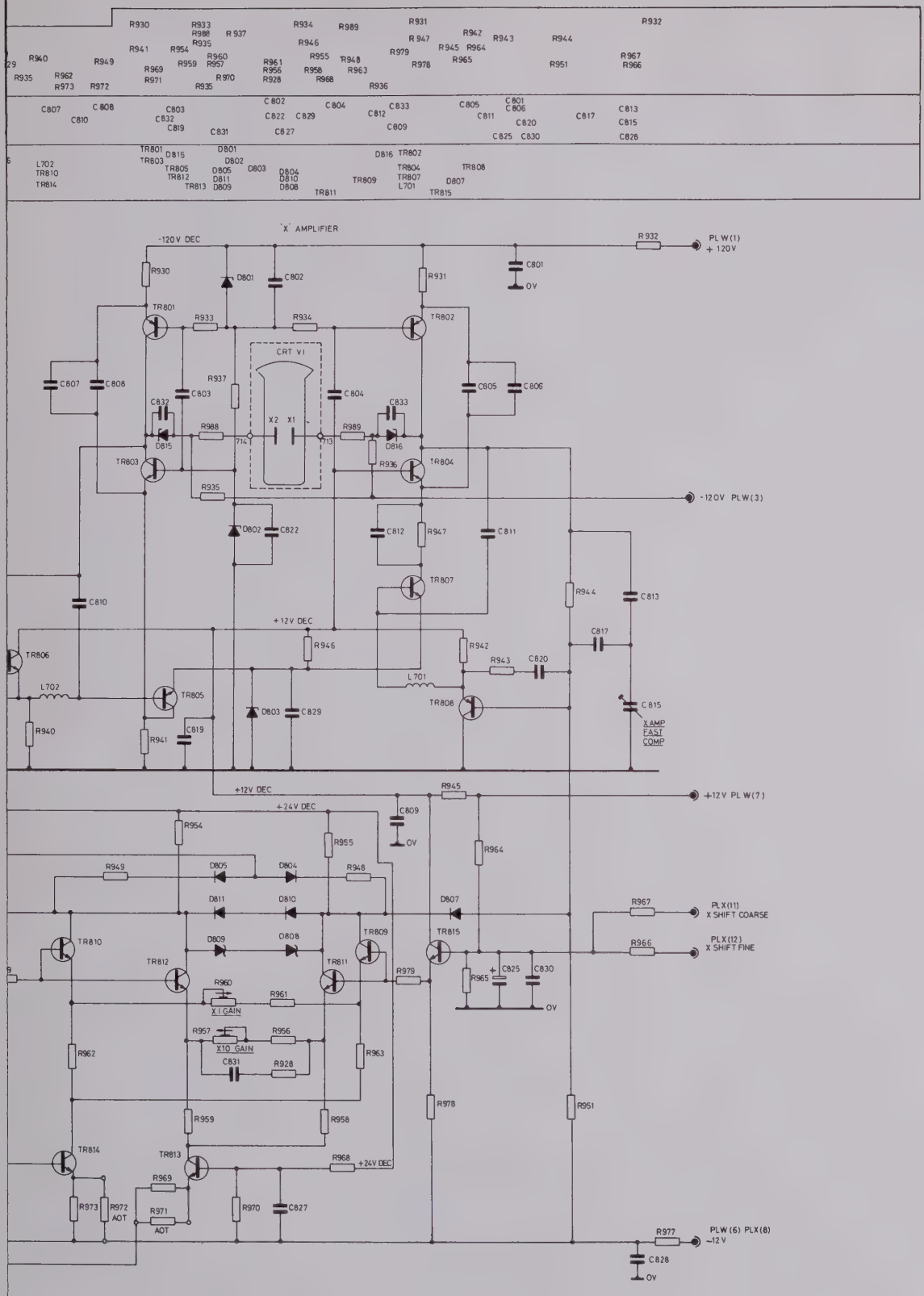


Fig. 7B Timebase,'X' O/P & Calibrator Circuit Diagram

OS3600 'Y' PRE-AMP BEAM SWITCH 'Y' DRIVER & O/P

Ref	Value	Description	Tol %±	Part No
RESISTORS				
R11	4k7	CP Pot Y Shift		A4/42203
R12	4k7	CP Pot Y Shift		A4/42203
R13	2k2	CP Log. (+S7) Fine Gain		A4/42993
R14	2k2	CP Log. (+S8) Fine Gain		A4/42993
R27	47	CF		28714
R28	100	CF		21794
R43	56	CF		28715
R44	56	CF		28715
R45	39	CF		28713
R46	39	CF		28713
R47	10	CF		21793
R48	10	CF		21793
R49	10	CF		21793
R50	10	CF		21793
R51	10	CF		21793
R52	10	CF		21793
R53	18	CF		28709
R54	18	CF		28709
R55	10k	CF		21809
R56	10k	CF		21809
R59	39	CF		28713
R60	39	CF		28713
R61	39	CF		28713
R62	39	CF		28713
R63	39	CF		28713
R64	39	CF		28713
R71	900k	MF	0.5	31929
R72	900k	MF	0.5	31929
R73	111k	MF	0.5	31930
R74	111k	MF	0.5	31930
R75	990k	MF	0.5	31927
R76	990k	MF	0.5	31927
R77	10k1	MF	0.5	37778
R78	10k1	MF	0.5	37778
R79	100k	MF		38642
R80	100k	MF		38642
R81	1k2	CF		21800
R82	1k2	CF		21800
R83		Resistor Network		A3/43135
R84		Resistor Network		A3/43136
R85	900k	MF	0.5	31929
R86	900k	MF	0.5	31929
R87	270	MF		38580
R88	270	MF		38580
R89	270	MF		38580
R90	270	MF		38580
R91	470k	CC		4906
R92	470k	CC		4906
R93	470k	CC		4906
R94	470k	CC		4906
R95	75	MF		38567
R96	75	MF		38567

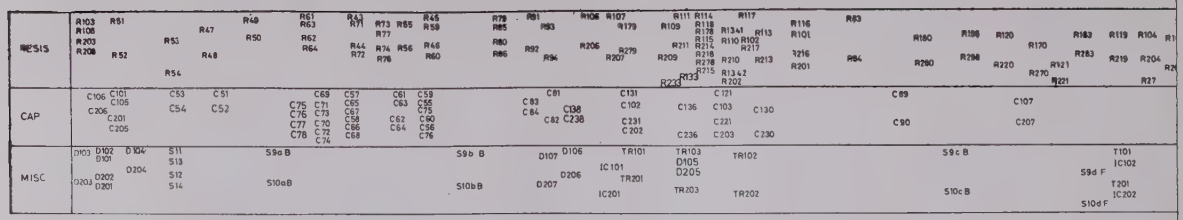
Ref	Value	Description	Tol %±	Part No
R101	22	CF		28710
R102	10	CF		21793
R103				
R104	47	CF	1/8W	43146
R105	47	CF	1/8W	43146
R106	82	CF	1/8W	43149
R107	1k	CF		21799
R108	2k2	CF		21802
R109	22k	CF		21812
R110	100	CF		21794
R111	47	CF	1/8W	43146
R112	10	CF		21793
R113	820	CF		28724
R114	47	CF	1/8W	43146
R115	10k	CF		21809
R116	1k2	CF		21800
R117	10	CF		21793
R118	470	CF		21797
R119	150	MF		38574
R120	2k	MF		38601
R121	2k	MF		38601
R122	10	CF		21793
R123	220	CF	1/8W	43359
R124	820	MF		38592
R125	820	MF		38592
R126	1k8	CF		28725
R127	100	CF	1/8W	43150
R128	100	CF	1/8W	43150
R129	470	CF		21797
R130	100	CF		21794
R131	100	CF		21794
R132	1k5	CF		21801
R133	390	CF		28722
R134	not used			
R135	10	CF		21793
R136	1k2	MF		38596
R137	1k2	MF		38596
R138	47	CF	1/8W	43146
R139	47	CF	1/8W	43146
R140	3k6	MF		38607
R141	22k	CF		21812
R142	470	CF		21797
R143	100	CF		21794
R144	100	CF		21794
R145	100	CF	1/8W	43150
R146	100	CF	1/8W	43150
R147	22	CF		28710
R148	270	MF		38580
R149	270	MF		38580
R150	560	MF		38588
R151	560	MF		38588
R152	470	MF	1	43622
R153	470	MF	1	43622
R154	470	CF		21797
R155	68	MF		38566

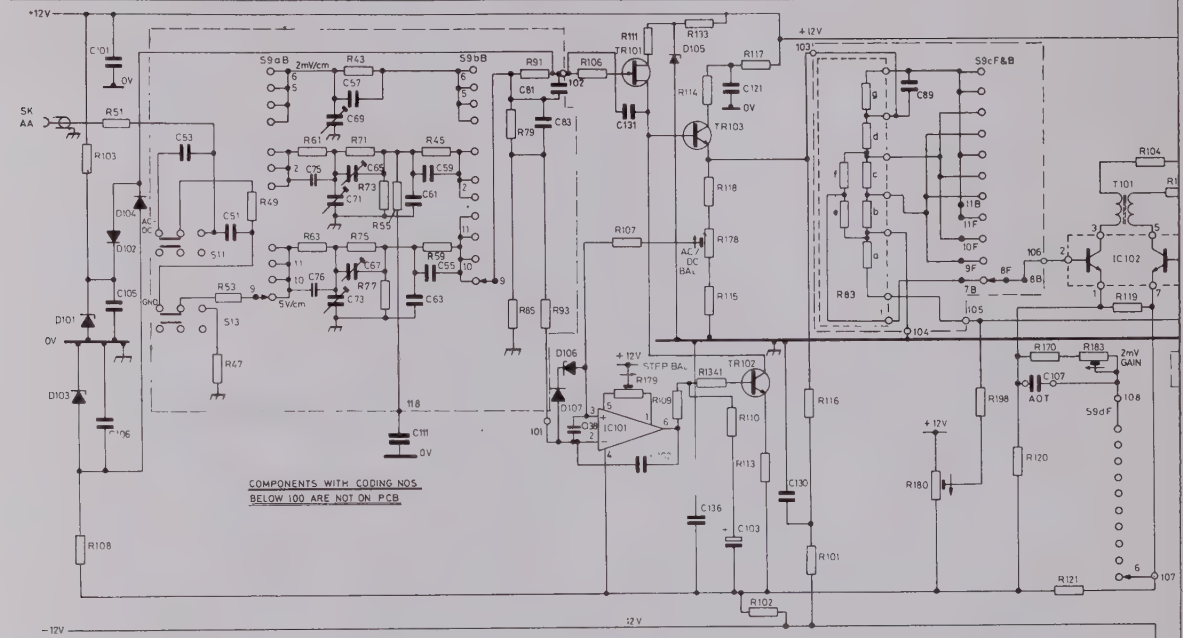
OS3600 'Y' PRE-AMP BEAM SWITCH, 'Y' DRIVER & O/P (Cont)

Ref	Value	Description	Tol %±	Part No	Ref	Value	Description	Tol %±	Part No
RESISTORS (Cont)									
R156	1k2	CF		21800	R211	47	CF	1/8W	43146
R157	1k2	CF		21800	R212	not used			
R158	3k	MF		38605	R213	820	CF		28724
R159	3k	MF		38605	R214	47	CF	1/8W	43146
R160	10	CF		21793	R215	10k	CF		21809
R161	51	MF		38563	R216	1k2	CF		21800
R162	10	CF		21793	R217	10	CF		21793
R163	47	CF		28714	R218	470	CF		21797
R164	330	CF		28721	R219	150	MF		38574
R165	330	CF		28721	R220	2k	MF		38601
R166	100	MF		38570	R221	2k	MF		38601
R167	100	MF		38570	R222	10	CF		21793
R168	620	MF		38589	R223	220	CF	1/8W	43359
R169	4k7	CF		21805	R224	820	MF		38592
R170	27	CF		28711	R225	820	MF		38592
R171	470	CF		21797	R226	1k8	CF		28725
R172	2k7	MF		38604	R227	100	CF	1/8W	43150
R173	2k7	CF		28726	R228	100	CF	1/8W	43150
R174	5k6	CF		21806	R229	470	CF		21797
R175	5k6	CF		21806	R230	100	CF		21794
R176	2.2k	CF		21802	R231	100	CF		21794
R177	2.2k	CF		21802	R232	1k5	CF		21801
R178	1k	PCP		39233	R233	390	CF		28722
R179	20k	PCP		39235	R234	not used			
R180	50k	PCP		39268	R235	10	CF		21793
R181	200	PCP		39231	R236	1k2	MF		38596
R182	50	PCP		39267	R237	1k2	MF		38596
R183	100	PCP		39230	R238	47	CF	1/8W	43146
R184	1k	PCP		39233	R239	47	CF	1/8W	43146
R185	1k	PCP		39233	R240	3k6	MF		38607
R186	47	CF		28714	R241	22k	CF		21812
R187	47	CF		28714	R242	470	CF		21797
R188	22	CF	1/8W	43142	R243	100	CF		21794
R189	2k2	CF	1/8W	43357	R244	100	CF		21794
R190	100	CF	1/8W	43150	R245	100	CF	1/8W	43150
R191	3k3	CF	1/8W	43358	R246	100	CF	1/8W	43150
R192	680	CF		28723	R247	22	CF		28710
R193	1k2	CF		21800	R248	270	MF		38580
R194	47	CF		28714	R249	270	MF		38580
R195	47	CF		28714	R250	560	MF		38588
R196	100	CF		21794	R251	560	MF		38588
R197	270	CF		28720	R252	470	MF	1	43622
R198	33k	CF		21814	R253	470	MF	1	43622
R199	220	CF		21796	R254	470	CF		21797
R200	not used				R255	68	MF		38566
R201	22	CF		28710	R256	1k2	CF		21800
R202	10	CF		21793	R257	1k2	CF		21800
R203					R258	3k	MF		38605
R204	47	CF	1/8W	43146	R259	3k	MF		38605
R205	47	CF	1/8W	43146	R260	10	CF		21793
R206	82	CF	1/8W	43149	R261	51	MF		38563
R207	1k	CF		21799	R262	10	CF		21793
R208	2k2	CF		21802	R263	47	CF		28714
R209	22k	CF		21812	R264	330	CF		28721
R210	100	CF		21794	R265	330	CF		28721

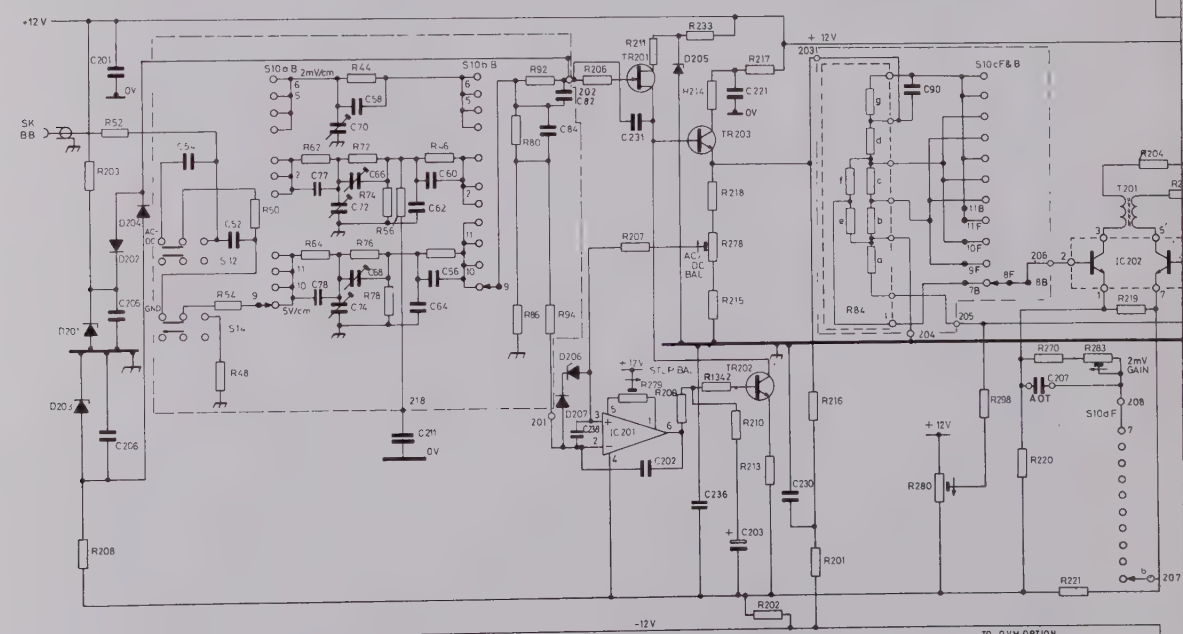
OS3600 'Y' PRE-AMP BEAM SWITCH, 'Y' DRIVER & O/P (Cont)

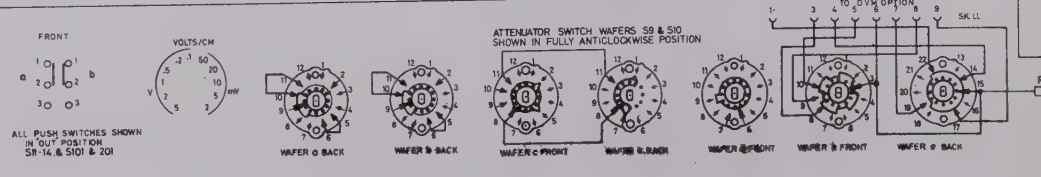
Ref	Value	Description	Tol %±	Part No
RESISTORS (Cont)				
R266	100	MF		38570
R267	100	MF		38570
R268	510	MF		38587
R269	1k	CF		21799
R270	27	CF		28711
R271	330	CF		28721
R272	12k	CF		21810
R273	1k	CF		21799
R274	10	CF		21793
R275	not used			
R276	2.2k	CF		21802
R277	2.2k	CF		21802
R278	1k	PCP		39233
R279	20k	PCP		39235
R280	50k	PCP		39268
R281	200	PCP		39231
R282	50	PCP		39267
R283	100	PCP		39230
R284	1k	PCP		39233
R285	not used			
R286	47	CF		28714
R287	47	CF		28714
R288	22	CF	1/8W	43142
R289	2k2	CF	1/8W	43357
R290	not used			
R291	3k3	CF	1/8W	43358
R292	680	CF		28723
R293	1k2	CF		21800
R294	47	CF		28714
R295	47	CF		28714
R298	33k	CF		21814
R301	47	CF		28714
R302	47	CF		28714
R303	33	CF		28712
R304	8k2	CF		21808
R305	100	CF	1/8W	43150
R306	100	CF	1/8W	43150
R307	560	CF		21798
R308	150	CF		28719
R309	150	CF		28719
R310	47	CF		28714
R311	47	CF		28714
R312	22	CF	1/8W	43142
R313	2k2	CF	1/8W	43357
R314	220	CF		21796
R315	3k3	CF	1/8W	43358
R316	620	MF		38589
R317	620	MF		38589
R318	100	CF	1/8W	43150
R319	100	CF	1/8W	43150
R320	150	CF		28719
R321	100	CF	1/8W	43150
R322	3k9	CF		21804
R323	2k2	CF		21802
R324	47	CF	1/8W	43146
R325	47	CF	1/8W	43146
R326	270	CF		28720
R327	270	CF		28720
R328	1k5	CF		21801
R329	33	CF		28712
R330	75	CF		38567
R331	75	CF		38567
R332	18k	CF		21811
R333		CF		
R334		CF	A.O.T	
R335	10	CF		21793
R336	47	CF	1/8W	43146
R337	47	CF	1/8W	43146
R338	100	CF	1/8W	43150
R339	100	CF	1/8W	43150
R340	10	CF		21793
R341	200	PCP		39231
R342	430	MF		38585
R343	430	MF		38585
R344	220	CF		21796
R345	1k	CF		21799
R346	1k	CF		21799
R347	100	CF	1/8W	43150
R348	100	CF	1/8W	43150
R349	820	CF		28724
R350	820	CF		28724
R351	not used			
R352	51	MF		38563
R353	120	CF		28718
R354	47	CF	1/8W	43146
R355	1k5	CF		21801
R356	1k	PCP		39233
R357	3k3	CF		21803
R358	100k	CF		21819
R359	1k	CF		21799
R360	10	CF		21793
R361	2k2	CF		21802
R362	2k2	CF		21802
R363	1k2	CF		21800
R364	470	CF		21797
R365	680	CF		28723
R366	330	CF		28721
R367	1k	PCP		39233
R368	47	CF		28714
R369	47	CF		28714
R370		Resistor Network 2.2k 8 way		43185
R371		Resistor Network 2.2k 8 way		43185
R372	47	CF		28714
R373	47	CF		28714
R374	47	CF		28714
R375	47	CF		28714





Y PREAMPLIFER PCB ASSY 43206





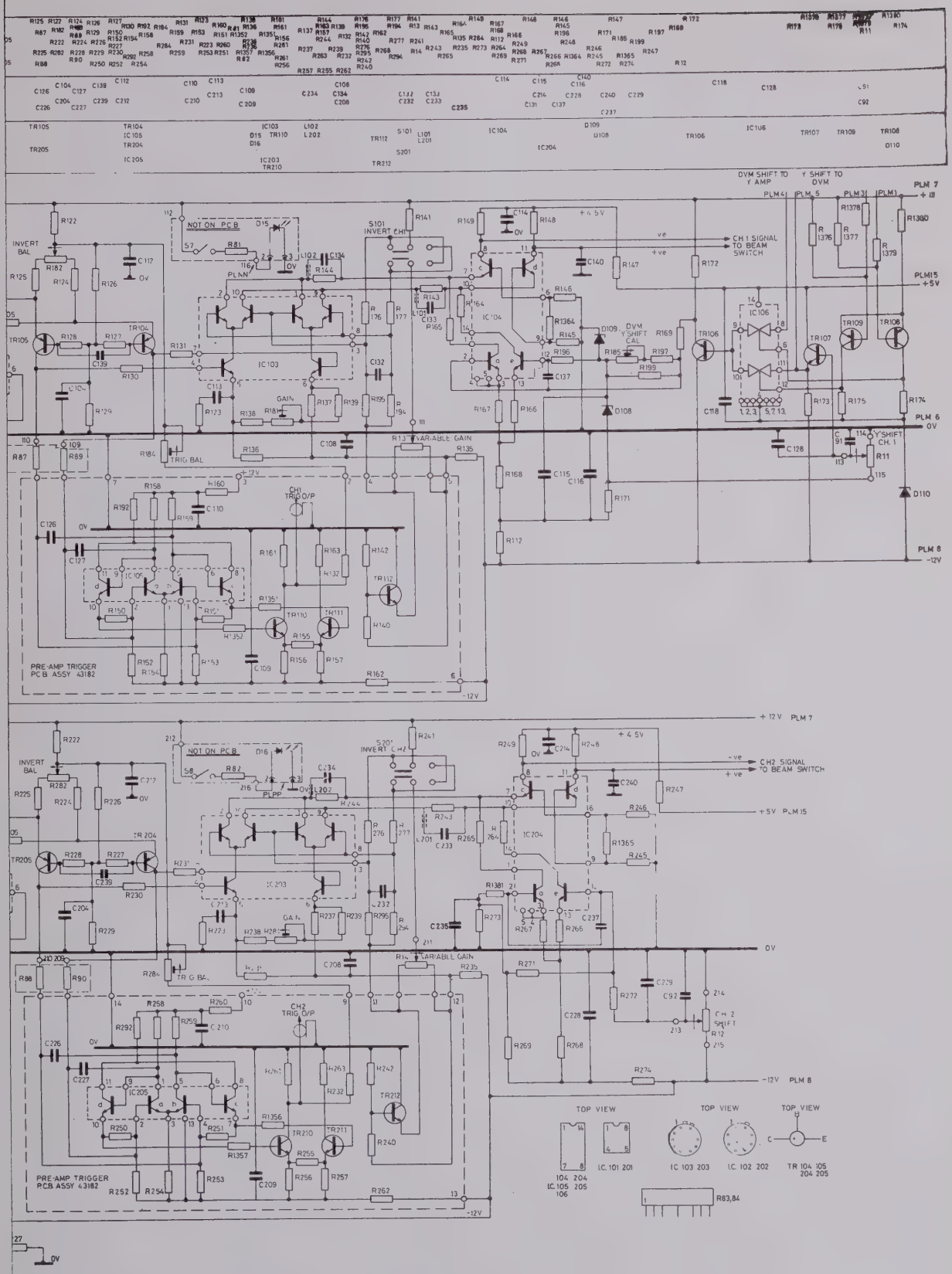


Fig. 8 'Y' Pre-amp & Beam Switch Circuit Diagram

OS3600 'Y' PRE-AMP BEAM SWITCH, 'Y' DRIVER & O/P (Cont)

Ref	Value	Description	Tol %±	Part No
RESISTORS (Cont)				
R376	1k	CF		21799
R377	2k2	CF		21802
R378	2k2	CF		21802
R379	100	CF	1/8W	43150
R380	100	CF	1/8W	43150
R381	10	CF		21793
R382	10k	PCP		39265
R383	5k6	CF		21806
R384	5k6	CF		21806
R385	1k	CF		21799
R386	2k2	CF		21802
R387	1k2	CF		21800
R388	1k	CF		21799
R389	1k	CF		21799
R390	1k2	CF		21800
R391	1k2	CF		21800
R392	1k	CF		21799
R393	1k	CF		21799
R394	750	MF		38591
R395	2k2	CF		21802
R396	330	CF		28721
R397	100	CF	1/8W	43150
R398	100	CF	1/8W	43150
R399	100	CF	1/8W	43150
R401	100	CF		21794
R402	680	CF		28723
R403	100	CF		21794
R404	680	CF		28723
R405	100	CF		21794
R406	100	CF		21794
R407	470	CF		21797
R408	820	CF		28724
R409	560	CF		21798
R410	560	CF		21798
R411	330	CF		28721
R412	270	CF		28720
R413	270	CF		28720
R414	180	CF		21795
R415	82	CF		28717
R416	82	CF		28717
R417	560	CF		21798
R418	560	CF		21798
R419	not used			
R420	10k	CF		21809
R421	4k7	CF		21805
R422	180	CF		21795
R423	180	CF		21795
R424	470	CF		21797
R425	150	CF	A.O.T.	28719
R426	22	CF		28710
R428	150	CF		28719
R429	470	CF	½W	18546
R430	not used			
R431	100	CF		21794
R432	220k	CF		21823
R433	6M2	MG	½W	42132
R434	560	CF		21798
R435	1k	CP	Scale Illum.	A4/38680
R436	2k2	CP	Trace Rotation	A4/38678
R437	10k	CP	Intensity	A4/38681
R438	1M	CP	Focus	A4/38679
R439	100k	PCP		39269
R440	1M	PCP		39431
R441	not used			
R442	1k	CF		21799
R443	not used			
R444	47	CF		28714
R447	39k	CF		28728
R448	82k	CF		21818
R449	not used			
R450	10	CF		21793
R451	10	CF		21793
R452	1k5	CF		21801
R453	47	CF		28714
R454	47	CF		28714
R455	68	CF		28716
R456	33	CF	A.O.T.	28712
R457	10	CF		21793
R471	10	CF		21793
R472	10	CF		21793
R473	510	MO	5 6W	40318
R474	510	MO	5 6W	40318
R475	10	CF		21793
R476	47	CF	½W	18534
R1341	100	CF		21794
R1342	100	CF		21794
R1351	47	CF		28714
R1352	47	CF		28714
R1356	47	CF		28714
R1357	47	CF		28714
R1362	100	CF	1/8W	43150
R1363	not used			
R1364	47	CF		28714
R1365	47	CF		28714
R1366	22	CF	1/8W	43142
R1367	22	CF	1/8W	43142
R1368	22	CF	1/8W	43142
R1369	390	CF	A.O.T.	28722
R1370	1k	CF		21799
R1371	110	CF		21796
R1372	3k3	CF		21803
R1373	820	CF		28724
R1374	1k5	CF		21801

OS3600 'Y' PRE-AMP BEAM SWITCH, 'Y' DRIVER & O/P (Cont)

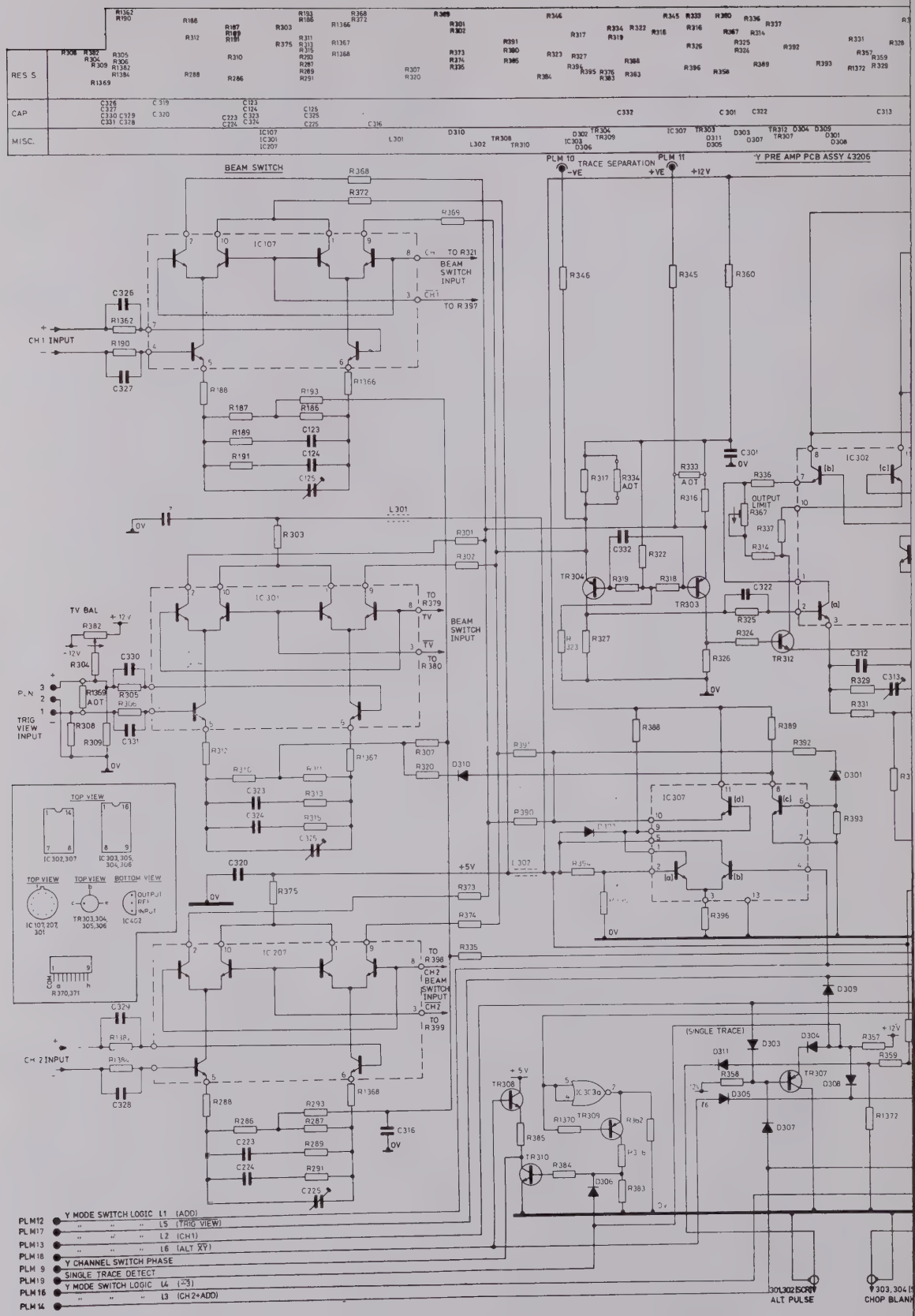
Ref	Value	Description	Tol %±	Part No
RESISTORS (Cont)				
R1375	not used			
R1376	5k6	CF		21806
R1377	5k6	CF		21806
R1378	5k6	CF		21806
R1379	5k6	CF		21806
R1380	2k7	CF		28726
R1381	330	CF		28721
R1382	100	CF	1/8W	43150
R1383	not used			
R1384	100	CF	1/8W	43150
CAPACITORS				
C51	4700pF	CE(1)		22393
C52	4700pF	CE(1)		22393
C53	0.1μF	PE	400V	29495
C54	0.1μF	PE	400V	29495
C55	10pF	CE(2)		22364
C56	10pF	CE(2)		22364
C57	27pF	CE(2)		22369
C58	27pF	CE(2)		22369
C59	8.2pF	CE(2)		22363
C60	8.2pF	CE(2)		22363
C61	47pF	Button Mica		29918
C62	47pF	Button Mica		29918
C63	330pF	Button Mica		31293
C64	330pF	Button Mica		31293
C65	2/10pF	TRIMMER		A4/43123
C66	2/10pF	TRIMMER		A4/43123
C67	2/10pF	TRIMMER		A4/43123
C68	2/10pF	TRIMMER		A4/43123
C69	2/10pF	TRIMMER		43183
C70	2/10pF	TRIMMER		43183
C71	2/10pF	TRIMMER		43183
C72	2/10pF	TRIMMER		43183
C73	2/10pF	TRIMMER		43183
C74	2/10pF	TRIMMER		43183
C75	22pF	CE(2)		22368
C76	18pF	CE(2)		22367
C77	22pF	CE(2)		22368
C78	18pF	CE(2)		22367
C79	.01μF	CE(1)		22395
C80	.01μF	CE(1)		22395
C81	2,200pF	CE(1)		22389
C82	2,200pF	CE(1)		22389
C83	15pF	CE(2)		22366
C84	15pF	CE(2)		22366
C87	2.7pF	CE(3)		36599
C88	2.7pF	CE(3)		36599
C89	12pF	CE(2)		22365
C90	12pF	CE(2)		22365
C91	10nF	CE(2)		22395
C92	10nF	CE(2)		22395
C101	.01μF	CE(1)	250V	42569
C102	5.6pF	CE(2)		22361
C103	22μF	E	25V	32181
C104	.01μF	CE(1)	250V	42569
C105	.01μF	CE(1)	250V	42569
C106	.01μF	CE(1)	250V	42569
C107	5.6pF	CE(2)	A.O.T.	22361
C108	.01μF	CE(1)	250V	42569
C109	.01μF	CE(1)	250V	42569
C110	.01μF	CE(1)	250V	42569
C111	1pF	CE(3)		36594
C112	.01μF	CE(1)	250V	42569
C113	5.6pF	CE(3)		36603
C114	.01μF	CE(1)	250V	42569
C115	.01μF	CE(1)	250V	42569
C116	.01μF	CE(1)	250V	42569
C117	not used			
C118	.01μF	CE(1)	250V	42569
C119	not used			
C120	not used			
C121	.01μF	CE(1)	250V	42569
C122	not used			
C123	12pF	CE(3)		36607
C124	330pF	CE(2)	100V	43438
C125	4/27pF	FT		36273
C126	1pF	CE(3)		36594
C127	1pF	CE(3)		36594
C128	.01μF	CE(1)	250V	42569
C129	not used			
C130	.01μF	CE(1)	250V	42569
C131	15pF	CE(2)		22366
C132	220pF	CE(2)		22379
C133	.01μF	CE(1)	250V	42569
C134	.01μF	CE(1)	250V	42569
C135	not used			
C136	.01μF	CE(1)	250V	42569
C137	220pF	CE(2)		22379
C138	120pF	CE(2)		22377
C139			A.O.T.	
C140			A.O.T.	
C201	.01μF	CE(1)	250V	42569
C202	5.6pF	CE(2)		22361
C203	22μF	E	25V	32181
C204	.01μF	CE(1)	250V	42569
C205	.01μF	CE(1)	250V	42569
C206	.01μF	CE(1)	250V	42569
C207	5.6pF	CE(2)	A.O.T.	22361
C208	.01μF	CE(1)	250V	42569
C209	.01μF	CE(1)	250V	42569
C210	.01μF	CE(1)	250V	42569
C211	1pF	CE(3)		36594
C212	.01μF	CE(1)	250V	42569
C213	5.6pF	CE(3)		36603
C214	.01μF	CE(1)	250V	42569
C221	.01μF	CE(1)	250V	42569
C222	not used			

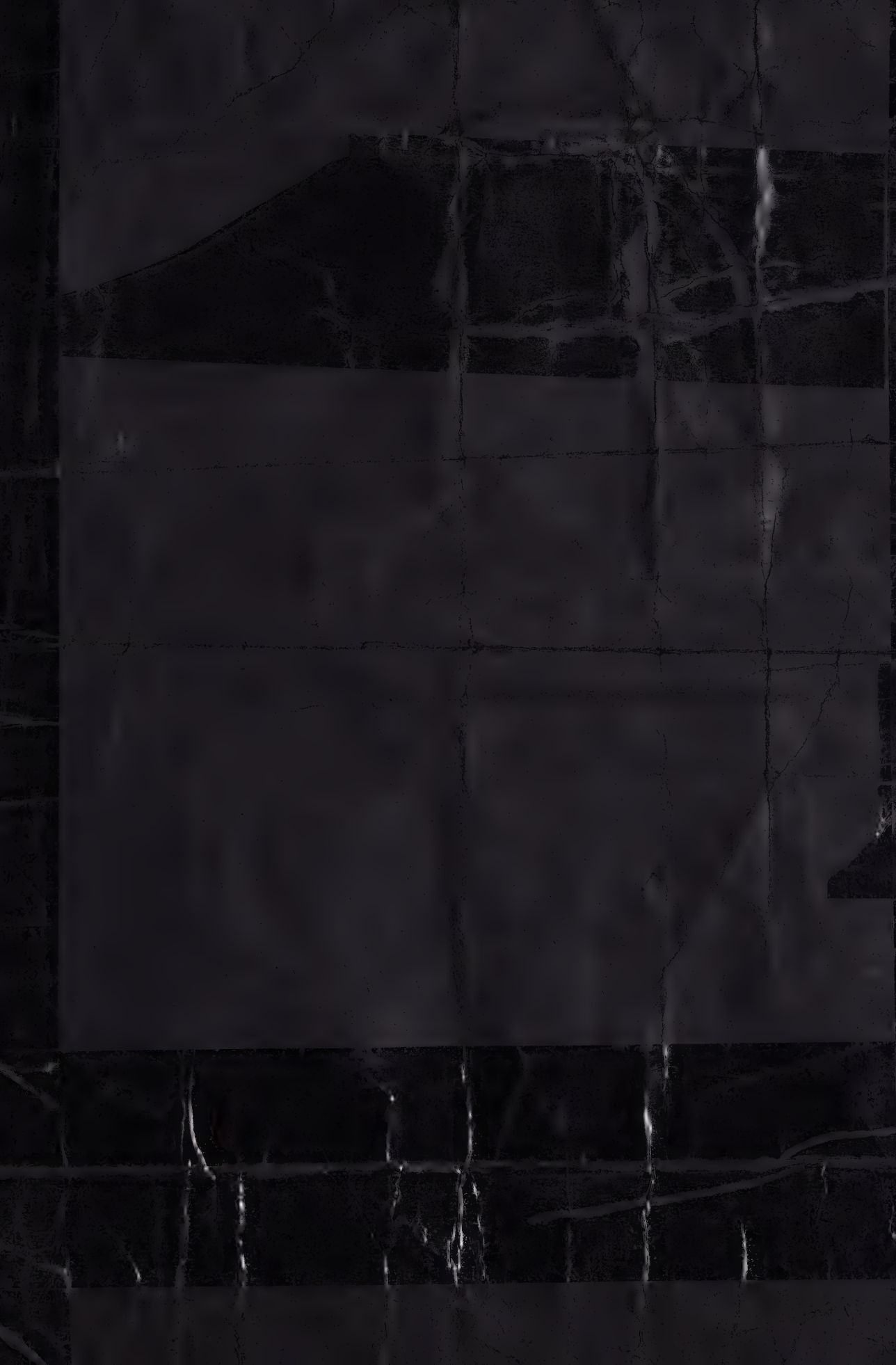
OS3600 'Y' PRE-AMP BEAM SWITCH, 'Y' DRIVER & O/P (Cont)

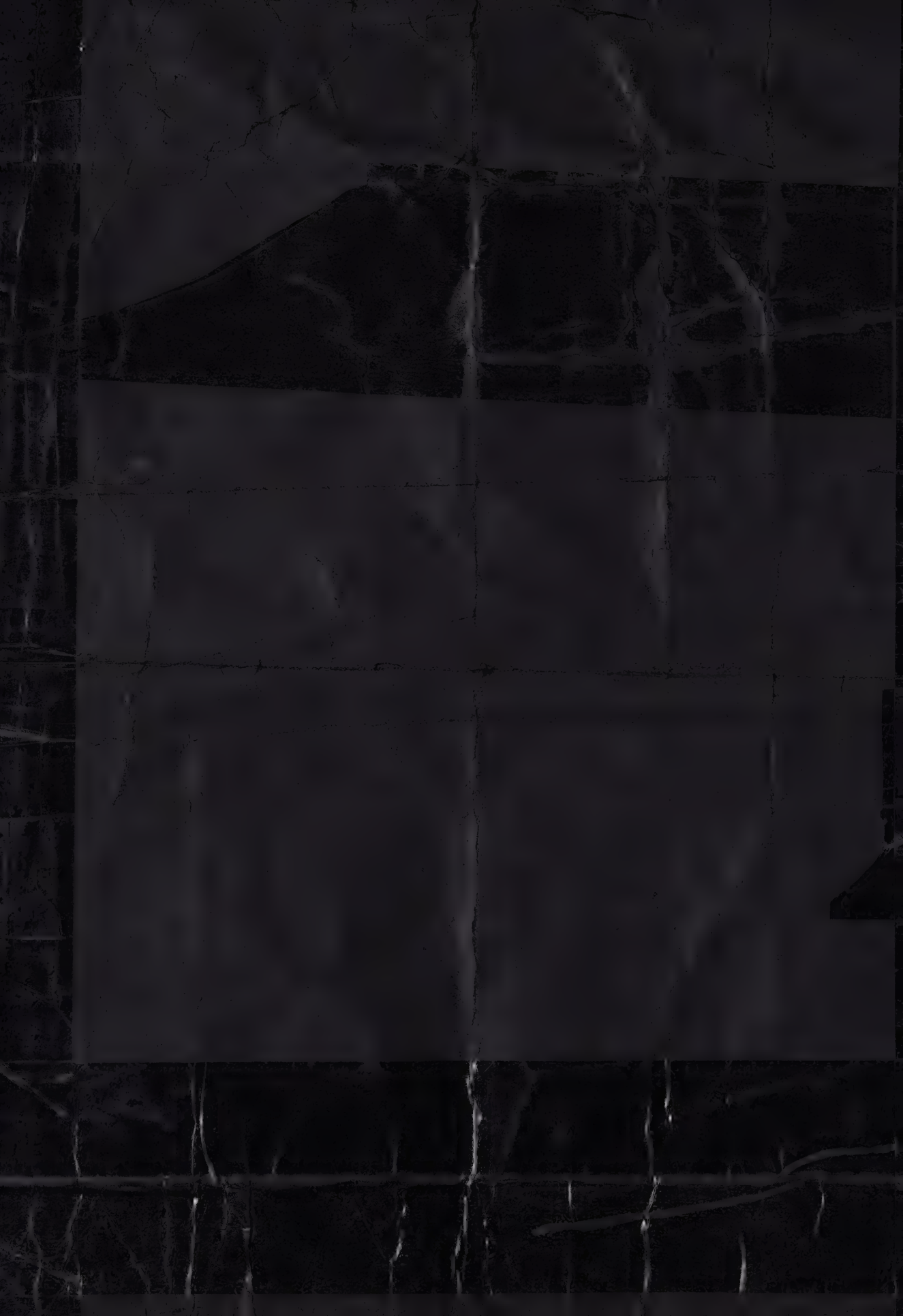
Ref	Value	Description	Tol %±	Part No
CAPACITORS (Cont)				
C223	12pF	CE(3)		36607
C224	330pF	CE(2)	100V	43438
C225	4/27pF	FT		36273
C226	1pF	CE(3)		36594
C227	1pF	CE(3)		36599
C228	.01μF	CE(1)	250V	42569
C229	.01μF	CE(1)	250V	42569
C230	.01μF	CE(1)	250V	42569
C231	15pF	CE(2)		22366
C232	220pF	CE(2)		22379
C233	.01μF	CE(1)	250V	42569
C234	.01μF	CE(1)	250V	42569
C235	220pF	CE(2)		22379
C236	.01μF	CE(1)	250V	42569
C237	220pF	CE(2)		22379
C238	120pF	CE(2)		22377
C239			A.O.T.	
C240			A.O.T.	
C301	.01μF	CE(1)	250V	42569
C302	.01μF	CE(1)	250	42569
C303	22μF	E	25V	32181
C304	.01μF	CE(1)	250V	42569
C305	22μF	E	25V	32181
C306	.047μF	CE(1)	10V	19657
C307	.047μF	CE(1)	10V	19657
C308	.047μF	CE(1)	10V	19657
C309	.047μF	CE(1)	10V	19657
C310	270pF	CE(2)		22380
C311	not used			
C312	560pF	CE(2)		22384
C313	1.5/9pF	FT		36272
C314	not used			
C315	270pF	CE(2)		22380
C316	.01μF	CE(2)	250V	42569
C319	.047μF	CE(1)	10V	19657
C320	.047μF	CE(1)	10V	19657
C321	22μF	E	25V	32181
C322	5.6pF	CE(2)		22361
C323	12pF	CE(3)	50V	36607
C324	330pF	CE(2)	100V	43438
C325	4/27pF	FT		36273
C326	2.2pF	CE(3)		36598
C327	2.2pF	CE(3)		36598
C328	2.2pF	CE(3)		36598
C329	2.2pF	CE(3)		36598
C330	2.2pF	CE(3)		36598
C331	2.2pF	CE(3)		36598
C332	5.6pF	CE(2)		22361
C401	560pF	CE(2)		22384
C402	560pF	CE(2)		22384
C403	560pF	CE(2)		22384
C404	560pF	CE(2)		22384
C405	8.2pF	CE(2)		22363
C406	18pF	CE(2)		22367
C407	15pF	CE(2)		22366
C408	1.5/9pF	FT		36272
C409	4/27pF	FT		36273
C410	not used			
C411	.01μF	CE(1)	250V	22395
C412	8.2pF	CE(2)		22363
C413	.01μF	CE(1)	250V	22395
C414	not used			
C415	.01μF	CE(1)	250V	22395
C416	.01μF	CE(1)	250V	22395
C417	33μF	E	16V	32173
C418	.01μF	CE(1)	250V	22395
C419	5.6pF	CE(2)		22361
C471	.01μF	CE(1)	250V	22395
C472	.01μF	CE(1)	250V	22395
C473	.1μF	CE(1)	25V	36709
TRANSISTORS				
TR101		AE37		A4/40414
TR102		BF371		36275
TR103		MPS H10		40315
TR104		BF479		39270
TR105		BF479		39270
TR106		BC212		29327
TR107		BC182B		33205
TR108		BC212		29327
TR109		BC212		29327
TR110		MPS H10		40315
TR111		MPS H10		40315
TR112		BC182B		33205
TR201		AE37		A4/40414
TR202		BF371		36275
TR203		MPS H10		40315
TR204		BF479		39270
TR205		BF479		39270
TR210		MPS H10		40315
TR211		MPS H10		40315
TR212		BC182B		33205
TR303		BF479		39270
TR304		BF479		39270
TR305		BF479		39270
TR306		BF479		39270
TR307		BC212		29327
TR308		BC182B		33205
TR309		2N5771		38089
TR310		MPS 2369		36625
TR311		2N5771		38089
TR312		ZTX326A		41753
TR401		BF479		39270
TR402		BF479		39270
TR403		ZTX326A		41753
TR404		ZTX326A		41753

OS3600 'Y' PRE-AMP BEAM SWITCH, 'Y' DRIVER & O/P (Cont)

Ref	Value	Description	Tol % ±	Part No
TRANSISTORS (Cont)				
TR405		BFY51		29329
TR406		BFX88		23337
DIODES				
D101	3V3	ZENER		33923
D102		IN3595		29330
D103	3V3	ZENER		33923
D104		IN3595		29330
D105	8V2	ZENER		33933
D106	3V3	ZENER		33923
D107		IN3595		29330
D108	4V7	ZENER		33927
D109	4V7	ZENER		33927
D110	2V7	ZENER		33921
D201	3V3	ZENER		33923
D202		IN3595		29330
D203	3V3	ZENER		33923
D204		IN3595		29330
D205	8V2	ZENER		33933
D206	3V3	ZENER		33923
D207		IN3595		29330
D301	6V2	ZENER		33930
D302		IN4148		23802
D303		IN4148		23802
D304		IN4148		23802
D305		IN4148		23802
D306		IN4148		23802
D307		IN4148		23802
D308		IN4148		23802
D309		IN4148		23802
D310		IN4148		23802
D311		IN4148		23802
D401		IN4148		23802
D402	9V1	ZENER		33934
D403		IN4148		23802
D404		IN4148		23802
INTEGRATED CIRCUITS				
IC101		LF355BN		42050
IC102		SL360C		42126
IC103		SL2363C	Selected	42630
IC104		SL3145		40784
IC105		SL3145 CDP		43980
IC106		4066B		40044
IC107		SL2363C		42631
IC201		LF355BN		42050
IC202		SL360C		42126
IC203		SL2363C	Selected	42630
IC204		SL3145		40784
IC205		SL3145 CDP		43980
IC207		SL2363C		42631
IC301		SL2363C		42631
IC302		SL3145		40784
IC303		MC10102		39243
IC304		MC10102		39243
IC305		MC10103		40346
IC306		MC10135		42128
IC307		CA 3086		42907
IC402		78LO5		40406
IC471		OM504		42124
MISCELLANEOUS				
L101		Ferrite Bead FX1242		26986
L102		Ferrite Bead FX1242		26986
L201		Ferrite Bead FX1242		26986
L202		Ferrite Bead FX1242		26986
L301		Ferrite Bead FX1242		26986
L302		Ferrite Bead FX1242		26986
L471	1μH	Choke		41449
L472	1μH	Choke		41449
T101		Balancing Transformer		A4/43216
T102		Balancing Transformer		A4/43216
S7		CH1 Uncal Part of R13		A4/42993
S8		CH2 Uncal Part of R14		A4/42993
S9		Attenuator CH1		42135
S10		Attenuator CH2		42136
S11/12		AC/DC/GND CH1		A3/40734
S13/14		AC/DC/GND CH2		A3/40734
S101		Invert CH1		A3/40742
S201		Invert CH2		A3/40742
S400		Trace Locate		A3/40741
PLG		Molex 2-Way		41391
PLH		Molex 4-Way		41393
PLJ		Molex 2-Way		41391
PLK		Molex 3-Way		54181
PLL		Molex 12-Way		37879
PLM		Molex 19-Way		42502
PLN		Molex 3-Way		41395
SKAA		Socket BNC 50Ω		1222
SKBB		Socket BNC 50Ω		1222
PLNN		Molex 3-Way		37881
PLPP		Molex 3-Way		37881


RES S
CAP
MISC.
Y PRE AMP PCB ASSY 43206
BEAM SWITCH
TRACE SEPARATION
PLM 10
PLM 11
-VE
+VE
+12V
IC107
IC207
IC301
IC302
IC303
IC307
TO R321
BEAM SWITCH INPUT
TO R397
CH1 INPUT
TO R379
TO R380
TO R398
TO R399
CH2 BEAM SWITCH INPUT
CH 2 INPUT
TV BAL
TRIG VIEW INPUT
OUTPUT LIMIT
ALT PULSE
CHOP BLANK
(SINGLE TRACE)
TOP VIEW
BOTTOM VIEW
IC107,207,301
TR303,304,305,306
IC402
IC302,307
IC303,305,304,306
R370,371
PLM12 Y MODE SWITCH LOGIC L1 (ADD)
PLM17 " " " L5 (TRIG VIEW)
PLM13 " " " L2 (CH1)
PLM18 " " " L6 (ALT XY)
PLM 9 Y CHANNEL SWITCH PHASE
PLM19 SINGLE TRACE DETECT
PLM16 Y MODE SWITCH LOGIC L4 (-3)
PLM14 " " " L3 (CH2+ADD)





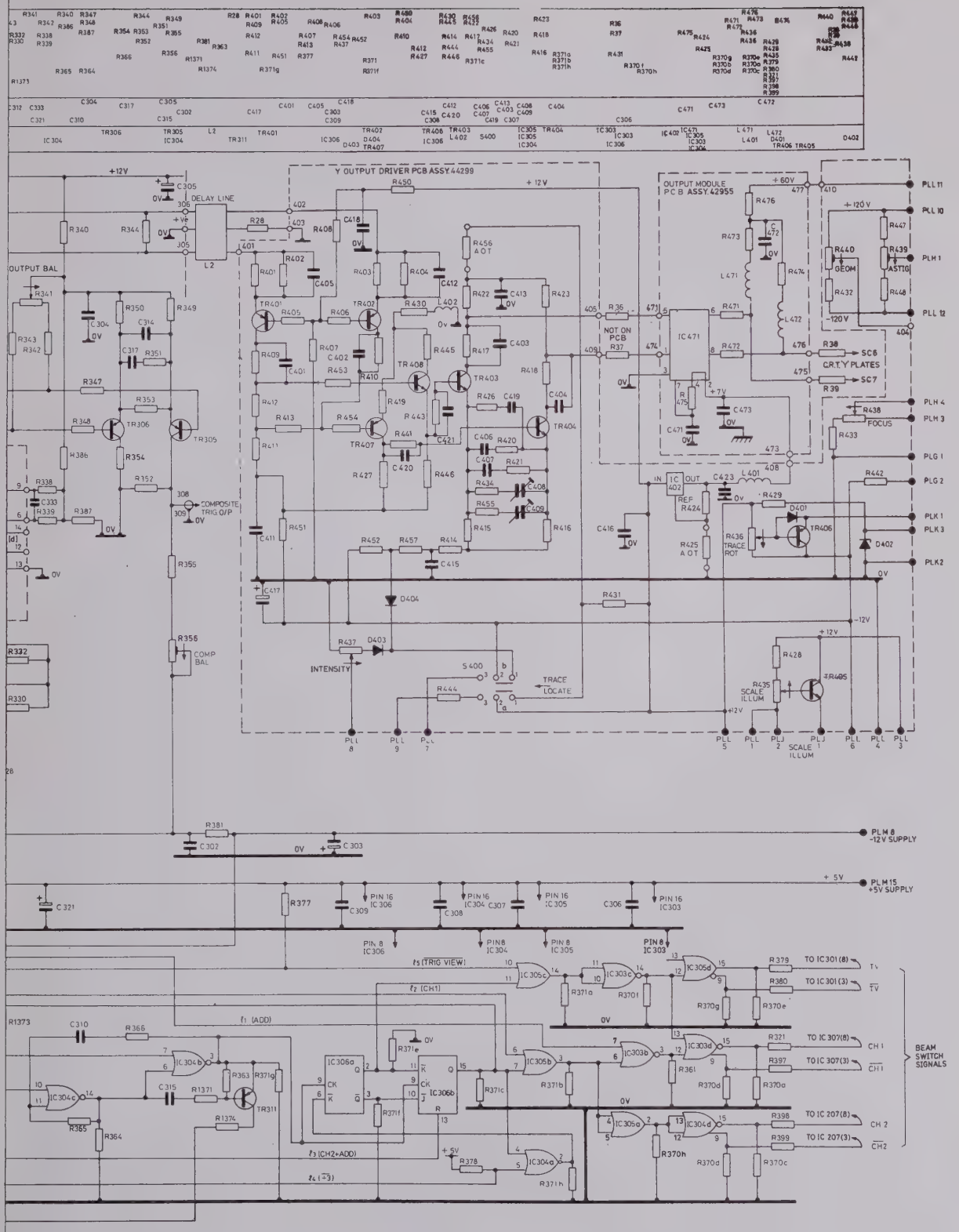


Fig. 9 'Y' Pre-amp Beam Switch, 'Y' Driver & O/P Circuit Diagram

OS3500 POWER SUPPLY

Ref	Value	Description	Tol % ±	Part No
RESISTORS				
R6	100k	CF		21819
R428	150	CF		28719
R429	470	CF	½W	18546
R432	220k	CF		21823
R433	6.2M	MG	5	42132
R435	1k0	CP	Scale illumination	A4/38680
R436	2k2	CP	Trace Rotate	A4/38678
R437	10k	CP	Intensity	A4/33681
R438	1M	CP	Focus	A4/38679
R439	100k	PCP	Astigmatism	39269
R440	1M	PCP	Geometry	39431
R444	47	CF		28714
R447	39k	CF		28728
R448	82k	CF		21818
R1001	2k2	CF		21802
R1002	39	CF		28713
R1003	4k7	MF		38610
R1004				
R1005	1k2	MF		38596
R1006				
R1007	10	CF		21793
R1008	2k2	MF		38602
R1009	1k5	CF		21801
R1010				
R1011	47	CF		28714
R1012	18k	CF		21811
R1013	5k6	CF		21806
R1014	5k6	MF		38612
R1015				
R1016	39k	CF		28728
R1017	100	CF		21794
R1018	680	CF		28723
R1019	36k	MF		38631
R1020				
R1021	1k	CF		21799
R1022	33k	CF		21814
R1023	68k	CF		21816
R1024	33k	CF		21814
R1025	6k8	MF		38614
R1026	100	CF		21794
R1027	1k8	WW	2½W	17823
R1028				
R1029	6k8	MF		38614
R1030				
R1031	4k7	MF		38610
R1032	3k3	CF		21803
R1033	10	CF		21793
R1034				
R1035	33k	CF		21814

Ref	Value	Description	Tol % ±	Part No
RESISTORS (Cont)				
R1036	33k	CF		21814
R1037				
R1038				
R1039	1M	CF		31840
R1040				
R1041	15	CF	1W	19026
R1042	2k7	MO		26728
R1043	200	MF		38577
R1044	2k	MF		38601
R1045				
R1046				
R1047	200	MF		38577
R1048	2k	MF		38601
R1049	243	MF	1	36628
R1050	750	MF	1	40369
R1051	100	PCP		39230
R1052	100	PCP		39230
R1053	1k5	CF		21801
R1054	5k6	MF		38612
R1055	47	CF		28714
R1056	18k	MF		38624
R1057	3k6	MF		38607
R1058	5k6	MF		21806
R1101	150	CF		28719
R1102	1k	CF		21799
R1103	68k	CF		21816
R1104				
R1105	22k	CF		21812
R1106	50k	PCP		39268
R1107				
R1108				
R1109	5k6	CF		21806
R1110				
R1111	1k5	CF		21801
R1112	220	CF		21796
R1113	1k	CF		21799
R1114	27k	CF		21813
R1115				
R1116				
R1117	100	CF		21794
R1118	10k	CF		21809
R1119	1M	PCP		39431
R1120	10k	CF		21809
R1121	15M	MG		40371
R1122				
R1123	10k	CF		21809
R1124	2M7	MG		42133
R1125	22M	MG		40787
R1126	27k	CF		21813
CAPACITORS				
C1	1000μF	E	100V	A4/40765
C2	6800μF	E	25V	A4/40766
C3	6800μF	E	25V	A4/40766

OS3600 POWER SUPPLY (Cont)

Ref	Value	Description	Tol %±	Part No
CAPACITORS (Cont)				
C1001	10nF	CE(1)	250V	22395
C1002	10nF	CE(2)	250V	22395
C1003	68pF	CE(1)		22374
C1004	10nF	CE(1)	250V	22395
C1005	10nF	CE(1)	250V	22395
C1006	22µF	E	25V	32181
C1007	10nF	CE(1)	250V	22395
C1008	100nF	PE	100V	37018
C1009	22µF	E	25V	32181
C1010	100pF	CE(2)		22376
C1011	10nF	CE(1)	250V	22395
C1012	10nF	CE(1)	250V	22395
C1014	47nF	CE(1)	4kV	40562
C1015	10nF	PE	5kV	37854
C1016	220µF	E	16V	42757
C1017	470µF	E	63V	40586
C1018				
C1019	220µF	E	100V	40587
C1021	220µF	E	100V	40587
C1022	22µF	E	25V	32181
C1023	22µF	E	25V	32181
C1024				
C1025	6800µF	E	16V	A4/40559
C1026	22µF	E	25V	32181
C1027	4.7µF	T	25V	53249
C1028	4.7µF	T	25V	53249
C1029	10µF	E	250V	42137
C1030	10µF	E	250V	42137
C1031	10nF	CE(1)	250V	22395
C1101	10nF	CE(1)	250V	22395
C1102	22µF	E	25V	32181
C1103				
C1104	100nF	PE	100V	37018
C1105	0.1µF	PE	250V	39199
C1106	220µF	E	16V	42757
C1107				
C1108				
C1109	1000pF	CE(1)	4kV	44443
C1110				
C1111	4700pF	CE(1)	4kV	40562
C1112	10nF	CE(1)	250V	22395
C1113	10nF	CE(1)	500V	24902
C1114	4.7nF	CE(1)	4kV	40562
C1115	4.7nF	CE(1)	4kV	40562
C1116	4.7nF	CE(1)	4kV	40562
C1117	100nF	CE(1)	25V	36709
TRANSISTORS				
TR405		BFY51		29329
TR406		BFX88		23337
TR1001		MPS3640		24128
TR1002		2N5771		38089

Ref	Value	Description	Tol %±		Part No
TRANSISTORS (Cont)					
TR1003		BC449			42131
TR1004		BC450			42130
TR1005		2N5771			38089
TR1006		TIP30A			38415
TR1007		BC182B			33205
TR1101		BC182B			33205
TR1102		BC212			29327
TR1103		2SC1173			36188
TR1104		BC212			29327
TR1105		BC449			42131
INTEGRATED CIRCUITS					
IC1001		LM317			40731
IC1002		LM317			40731
IC1003		LM317			40731
IC1004		µA723			31228
DIODES					
D1		IN4003			32771
D2		IN4003			32771
D3		IN4003			32771
D4		IN4003			32771
D5		IN4003			32771
D6		IN4003			32771
D7		IN4003			32771
D8		IN4003			32771
D9		IN4003			32771
D10		IN4003			32771
D401		IN4148			23802
D402	9V1	ZENER	5	400mW	33934
D1001		IN4148			23802
D1002		FH1100			40352
D1003		FH1100			40352
D1004		FH1100			40352
D1005		IN4149			1949
D1006		IN4149			1949
D1007		IN4148			23802
D1008	18V	ZENER	5	400mW	33941
D1009					
D1010		IN4003			32771
D1011		IN4003			32771
D1012		IN4003			23462
D1013		IN4148			23802
D1014					
D1015					
D1016	47V	ZENER	5	400mW	40049
D1017		IN4003			32771
D1018		IN4003			32771
D1019					
D1020					
D1021		IN4003			32771
D1022		IN4003			32771

OS3600 POWER SUPPLY (Cont)

Ref	Value	Description	Tol %±	Part No
DIODES (Cont)				
D1023		IN4003		32771
D1024				
D1025		IS923		3560
D1026		IN4148		23802
D1027		IN4148		23802
D1028		IN4003		32771
D1029		IN4003		32771
D1030		IN4148		23802
D1101		IN4148		23802
D1102		IN4148		23802
D1103		IN4148		23802
D1104		IN4148		23802
D1105		IN4148		23802
D1106				
D1107		BY409		42356
D1108		BY409		42356
D1109		IN4148		23802
D1110				
D1111		BY409		42356
D1112		BY409		42356
D1113				
D1114	150V	ZENER	1.3W	37559
D1115		IN4148		23802
MISCELLANEOUS				
BR1001		WO2		19725
BR1002		WO2		19725
L1		Rotation Coil	Part of V1	
L5		Ferrite Bead FX1242		26986
L6		Ferrite Bead FX1242		26986
L7		Ferrite Bead FX1242		26986
L8		Ferrite Bead FX1242		26986
L1101	150μH			35826
T1		Supply Transformer		A1/41751

Ref	Value	Description	Tol %±	Part No
MISCELLANEOUS (Cont)				
T1101		EHT Oscillator Transformer		A2/41747
S1		Power Switch		A4/36232
S15		Switch Slider Supply Volts Selection		4069
S16		Switch Slider Supply Volts Selection		4069
S400		Switch Push Button Trace Locate		40741
FS1	500mA	Fuse 20mm Slo-Blo 240V Supply		33685
FS1	1A	Fuse 20mm Slo-Blo 115V Supply		34790
FS1001	500mA	Fuse 20mm Slo-Blo		33685
PLA		Plug Molex 8 Way		43219
PLB		Plug Molex 9 Way		42633
PLC		Plug Molex 11 Way		40323
PLD		Plug Molex 8 Way		37877
PLF		Plug Molex 9 Way		A2/42634
PLJ		Plug Molex 2 Way		41391
PLK		Plug Molex 3 Way		54181
PLL		Plug Molex 12 Way		37879
PLQ		Plug Molex 2 Way LKG		41391
PLMM		IEC Supply Connector		33787
MPR1		EHT Multiplier		42452
V1		CRT D14-300GH Normal Version		42123
	or	D14/300GM/93 or D14-302GM/93 Long Persistence Version		42451
SKGG		Socket 4mm	Z Mod	29492
SKHH		Socket 4mm	0V	29492

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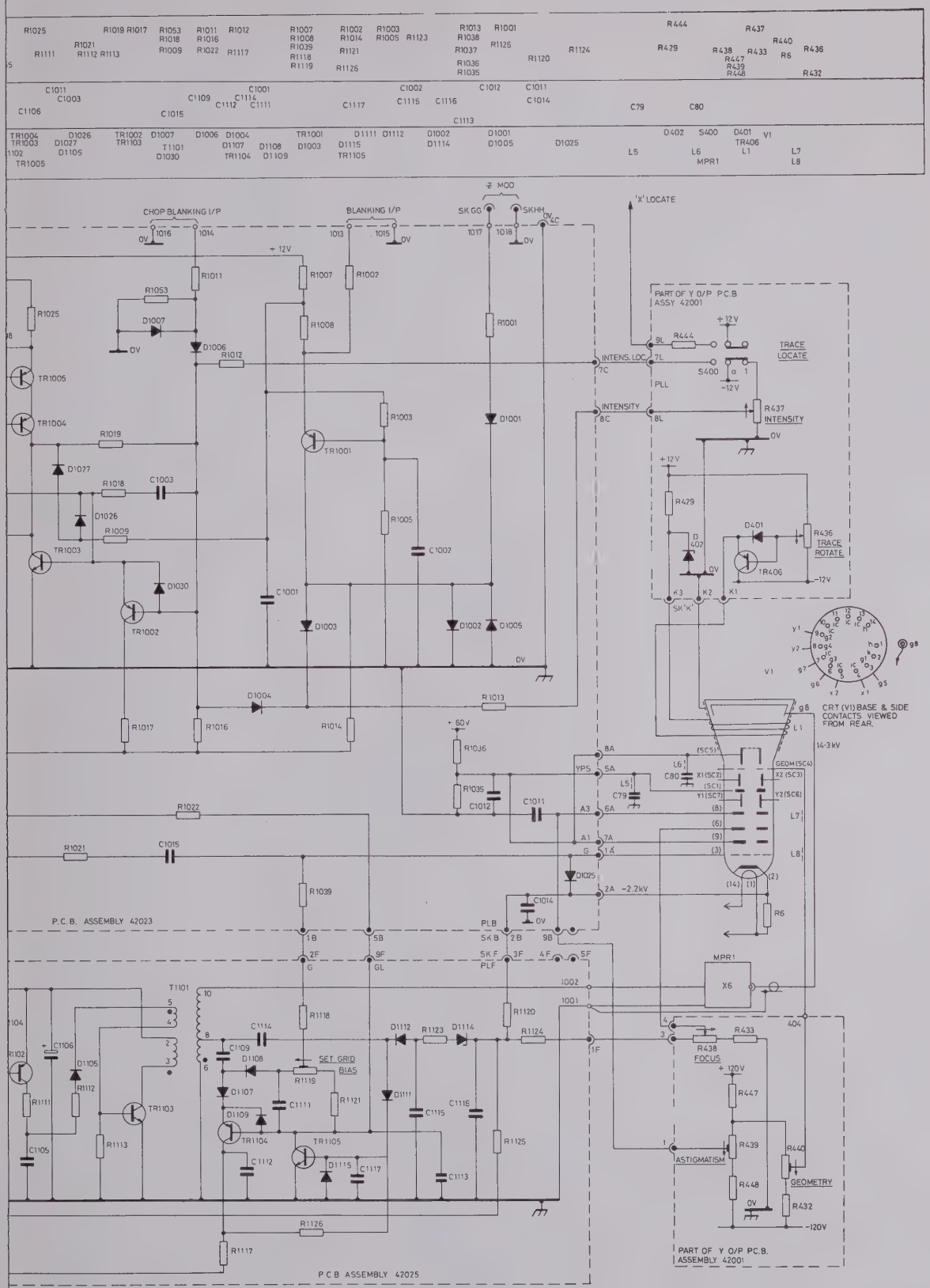


Fig. 10 Power Supply Circuit Diagram

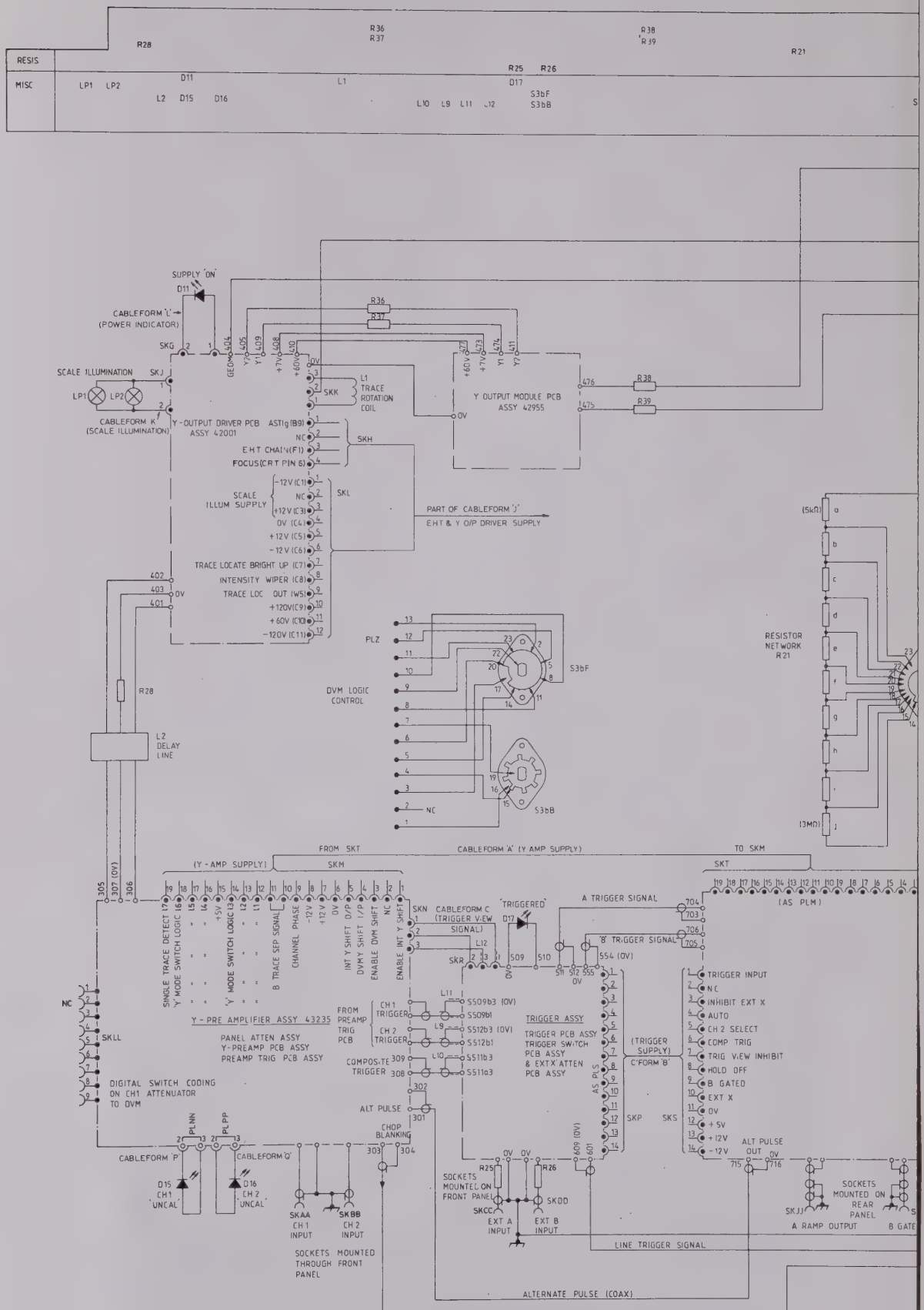
OS3600 INTERCONNECTIONS

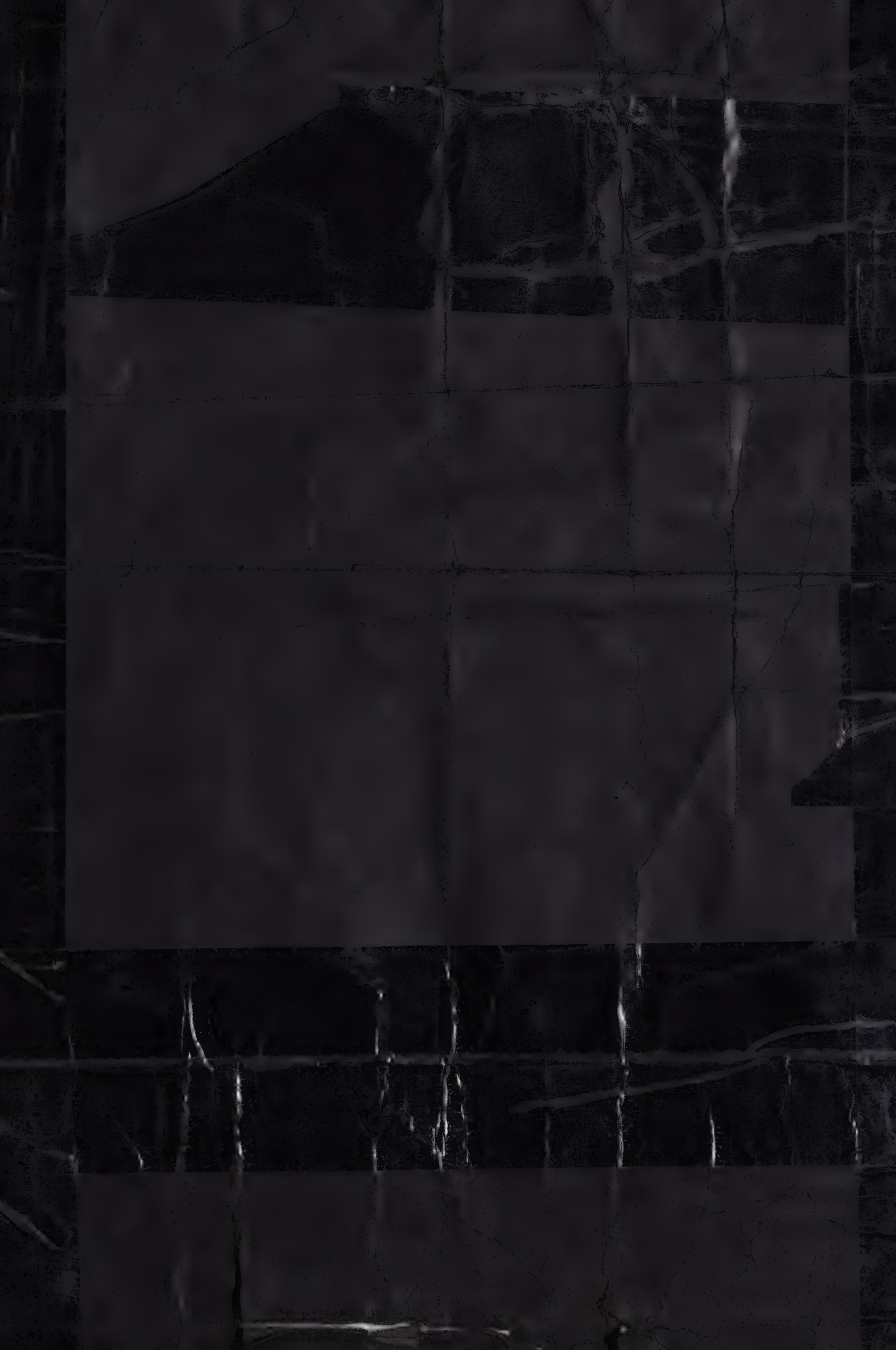
Ref	Value	Description	Tol %±	Part No
RESISTORS				
R2	10k	CP X Shift Coarse		A4/38689
R3	10k	CP X Shift Fine		
R4	10k	CP Trace Sep.		A4/38673
R5	5k	CP Delay		A4/38635
R6	100k	CF		21819
R7	10k	CP A Var Vel		A4/38675
R8	10k	CP B Var Vel		A4/38675
R9	2k2	CF		21802
R10	2k2	CF		21802
R11	4k7			A4/42203
R12	4k7			A4/42203
R15	1k1	MF	0.5	41784
R21		Resistor Network		A3/40102
R22		Resistor Network		A3/40103
R25	22	CF		28710
R26	22	CF		28710
R28	100	CF		21794
R36	10	CF		21793
R37	10	CF		21793
R38	47	CF		28714
R39	47	CF		28714
CAPACITORS				
C79	0.01μF	CE(1)	250V	22395
C80	0.01μF	CE(1)	250V	22395
L1		Rotation Coil Part of V1		–
L2		Delay Line		42647
L5		Ferrite Bead FX1242		26986
L6		Ferrite Bead FX1242		26986
L7		Ferrite Bead FX1242		26986
L8		Ferrite Bead FX1242		26986
L9		Ferrite Ring Part of Coax Cable P/No 43415		
L10		Ferrite Ring Part of Coax Cable P/No 43413		
L11		Ferrite Ring Part of Coax Cable P/No 43414		
L12		Ferrite Ring Part of C/Form Cable P/No A3/43660		
SWITCHES				
S2		Switch PULL X10 Part of R2 + R3		A4/38689

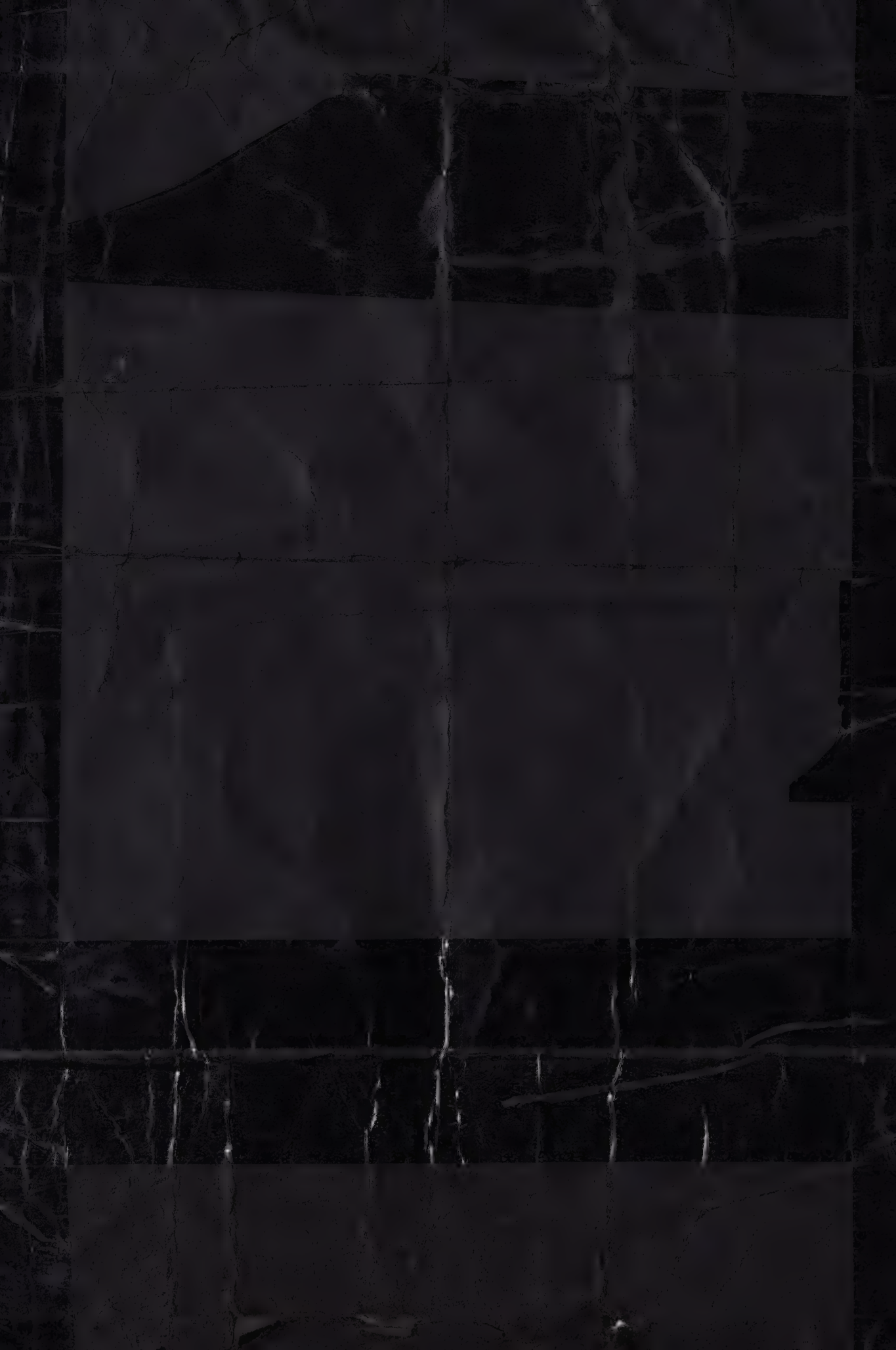
Ref	Value	Description	Tol %±	Part No
SWITCHES (Cont)				
S3		Switch "A" T/Base Range		38686
S4		Switch "B" " "		38687
S5		Switch "A" Uncal Part of R7		A4/38675
S6		Switch "B" Uncal Part of R8		A4/38675
DIODES				
D11		L.E.D.		39884
D12		L.E.D.		39884
D13		L.E.D.		39884
D14		L.E.D.		39884
D15		L.E.D.		39884
D16		L.E.D.		39884
D17		L.E.D.		39884
LAMPS				
LP1	12V	Lamp		40328
LP2	12V	Lamp		40328
MISCELLANEOUS				
V_1		CRT D14-300 GH Normal Version		42123
	OR	D14 300 GM Long Persistance Version		42451
MPR1		EHT Multiplier		42452
PLZ		Plug Molex 13 Way		39387
PLMM		IEC Supply Connector		33787
SKAA		Socket BNC Y_1 Input		1222
SKBB		Socket BNC Y_2 Input		1222
SKCC		Socket BNC Ext X "A" Input		1222
SKDD		Socket BNC Ext X "B" Input		1222
SKEE		Terminal Feedthru Cal Signal		31229
SKFF		Terminal 4mm Earth		A3/40833
SKGG		Socket 4mm Z Mod		29492
SKHH		Socket 4mm 0V		29492
SKJJ		Socket BNC "A" Ramp O/P		1222
SKKK		Socket BNC "B" Ramp O/P		1222
CABLEFORMS				
C/FORM				
A		Y Amp Supply		A3/42385
B		Trigger Amp Supply		A3/42644

OS3600 INTERCONNECTIONS (Cont)

Ref	*Value*	*Description*	*Tol %±*	*Part No*	*Ref*	*Value*	*Description*	*Tol %±*	*Part No*
CABLEFORMS (Cont)									
C		Trigger View Signal		A3/43660	J		EHT & Y Output Driver Supply		A2/42388
D		Timebase Supply		A3/42387					
E		A Timebase Controls		A3/41799	K		Scale Illumination		A3/41804
F		B Timebase Controls		A3/41800	L		Power Indicator		A4/41805
G		DVM Shorting Socket Use where No DIM Fitted		A4/41801	M		C.R.T. Supply		A3/42386
					P		Y_1 Uncal LED		A3/43659
					Q		Y_2 Uncal LED		A3/43659


RESIS
MISC
R28
R36
R37
R38
R39
R21
R25
R26
D11
D17
LP1
LP2
L1
L2
D15
D16
L10
L9
L11
L12
S3bF
S3bB
SUPPLY 'ON'
CABLEFORM 'L' (POWER INDICATOR)
SKG
GEOM
Y1
Y2
+7V
+60V
0V
SCALE ILLUMINATION
SKJ
CABLEFORM 'K' (SCALE ILLUMINATION)
L1 TRACE ROTATION COIL
SKK
Y OUTPUT MODULE PCB ASSY 42955
Y-OUTPUT DRIVER PCB ASSY 42001
ASTig (B9)
NC
E.H.T CHAIN (F1)
FOCUS (CRT PIN 6)
SKH
SCALE ILLUM SUPPLY
-12V (C1)
NC
+12V (C3)
0V (C4)
+12V (C5)
-12V (C6)
TRACE LOCATE BRIGHT UP (C7)
INTENSITY WIPER (C8)
TRACE LOC OUT (W5)
+120V (C9)
+60V (C10)
-120V (C11)
SKL
PART OF CABLEFORM 'J' E.H.T & Y O/P DRIVER SUPPLY
402
403
401
PLZ
DVM LOGIC CONTROL
NC
RESISTOR NETWORK R21
(5kΩ)
(13MΩ)
L2 DELAY LINE
FROM SKT
CABLEFORM 'A' (Y AMP SUPPLY)
TO SKM
(Y-AMP SUPPLY)
SKM
SKT
(AS PLM)
305
307 (0V)
306
SINGLE TRACE DETECT
'Y' MODE SWITCH LOGIC
'X' MODE SWITCH LOGIC
+5V
B TRACE SEP SIGNAL
CHANNEL PHASE
-12V
+12V
0V
INT Y SHIFT O/P
DVMY SHIFT I/P
ENABLE DVM SHIFT
NC
ENABLE INT Y SHIFT
SKN CABLEFORM C (TRIGGER VIEW SIGNAL)
'TRIGGERED'
A TRIGGER SIGNAL
'B' TRIGGER SIGNAL
554 (0V)
Y-PRE AMPLIFIER ASSY 43235
PANEL ATTEN ASSY
Y-PREAMP PCB ASSY
PREAMP TRIG PCB ASSY
FROM PREAMP TRIG PCB
CH 1 TRIGGER
CH 2 TRIGGER
COMPOSITE TRIGGER
SS09b3 (0V)
SS09b1
SS12b3 (0V)
SS12b1
SS11b3
SS11a3
TRIGGER ASSY
TRIGGER PCB ASSY
TRIGGER SWITCH PCB ASSY
& EXT X ATTEN PCB ASSY
(TRIGGER SUPPLY) C'FORM 'B'
SKP
SKS
TRIGGER INPUT
N.C
INHIBIT EXT X
AUTO
CH 2 SELECT
COMP TRIG
TRIG VIEW INHIBIT
HOLD OFF
B GATED
EXT X
0V
+5V
+12V
-12V
ALT PULSE OUT
SKLL
DIGITAL SWITCH CODING ON CH1 ATTENUATOR TO DVM
ALT PULSE
CHOP BLANKING
PLNN
PLPP
CABLEFORM 'P'
CABLEFORM 'Q'
D15 CH1 'UNCAL'
D16 CH2 'UNCAL'
SKAA CH 1 INPUT
SKBB CH 2 INPUT
SOCKETS MOUNTED THROUGH FRONT PANEL
SOCKETS MOUNTED ON FRONT PANEL
SKCC EXT A INPUT
SKDD EXT B INPUT
SOCKETS MOUNTED ON REAR PANEL
SKJJ A RAMP OUTPUT
B GATE
LINE TRIGGER SIGNAL
ALTERNATE PULSE (COAX)





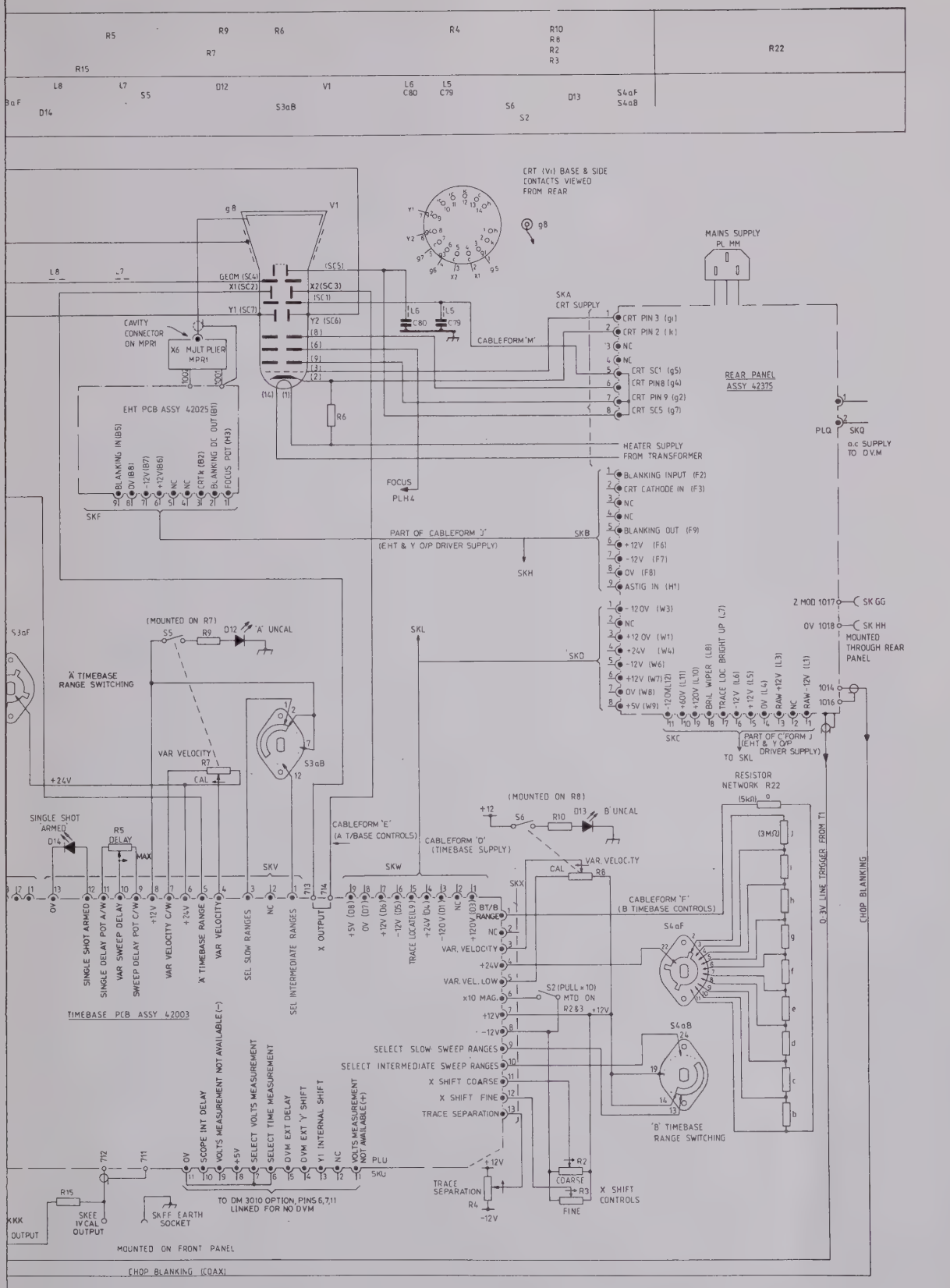


Fig. 11 Interconnections Circuit Diagram

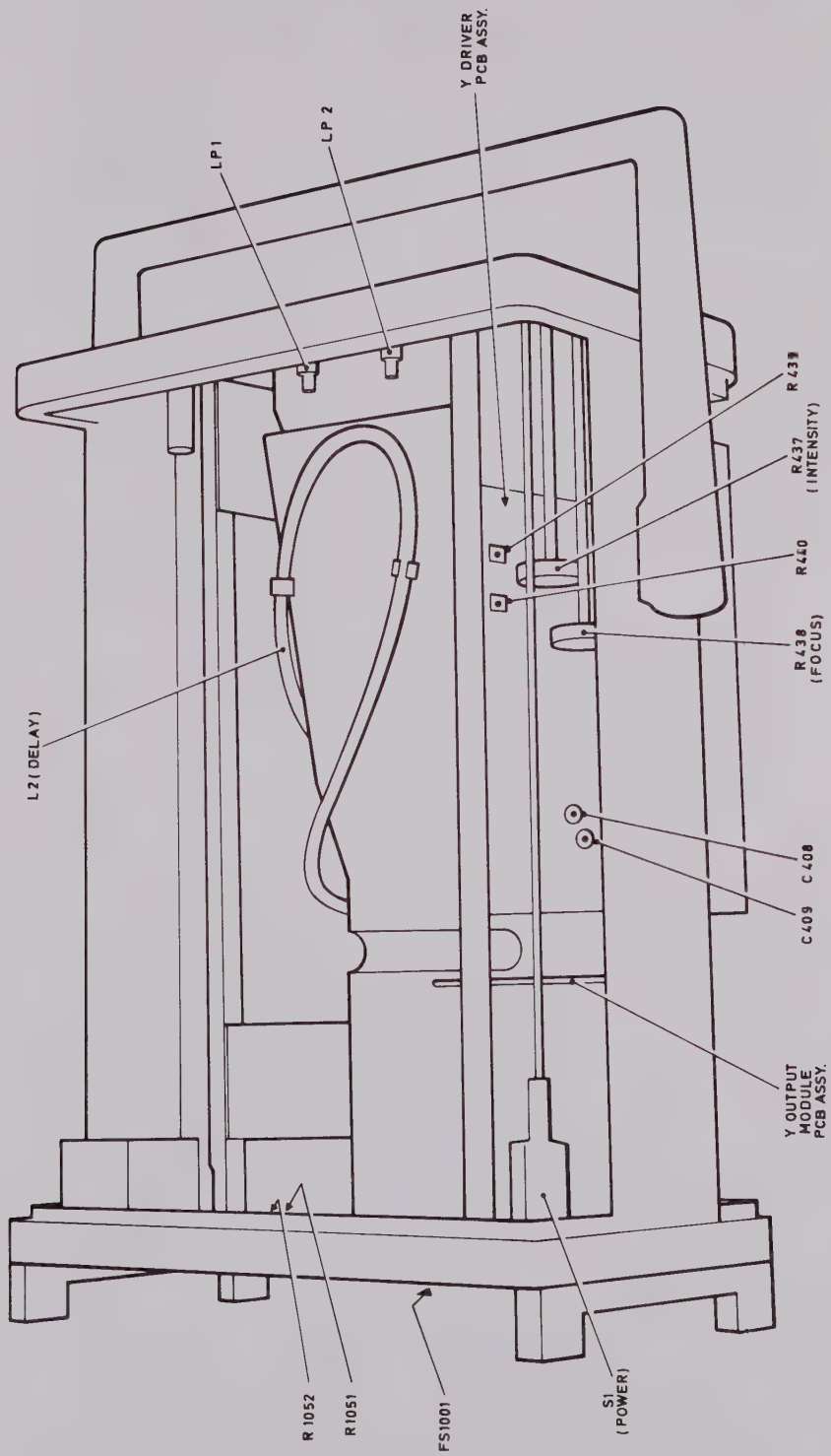


Fig. 12 Component Location Top Left View

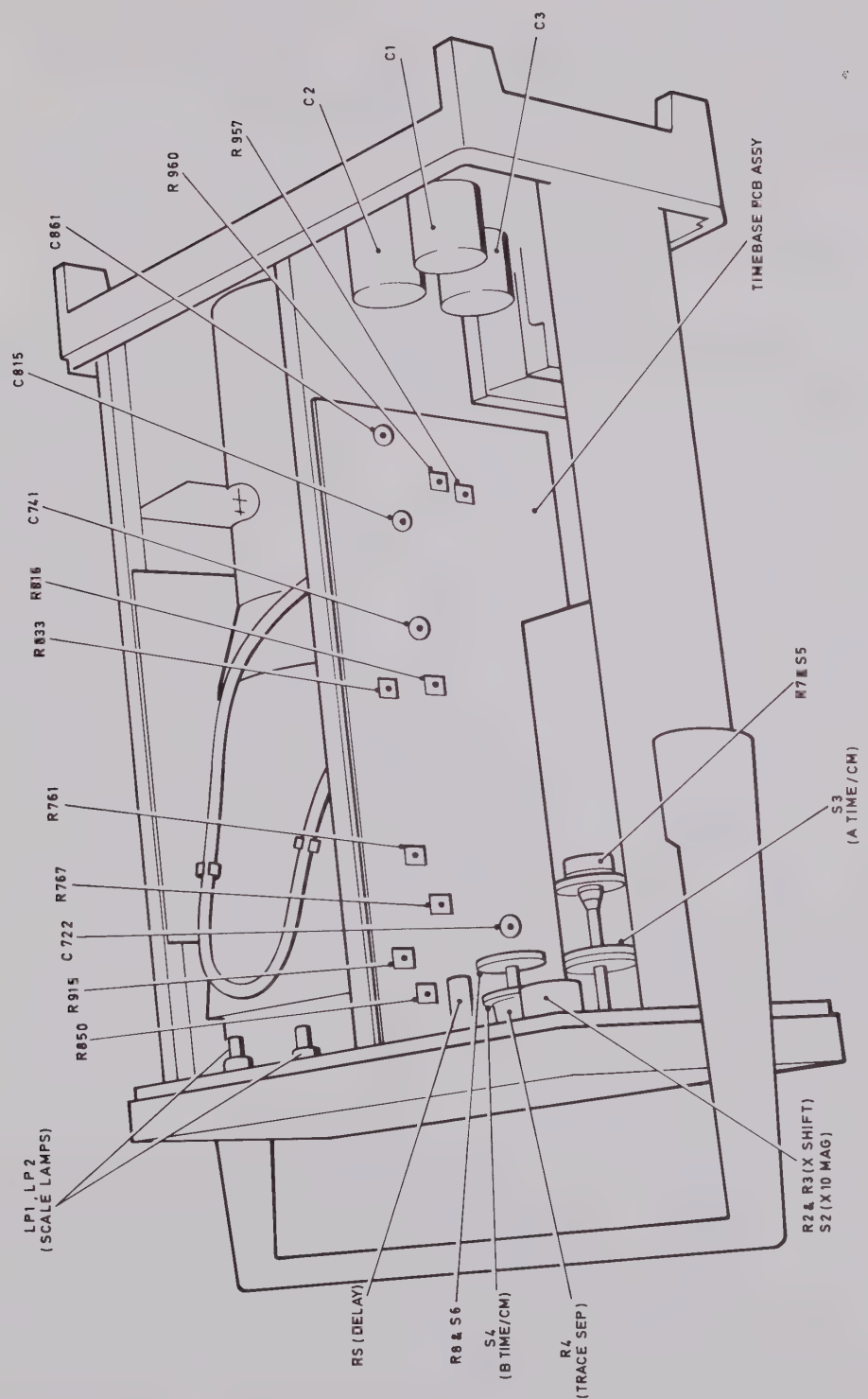


Fig. 13 Component Location Top Right View

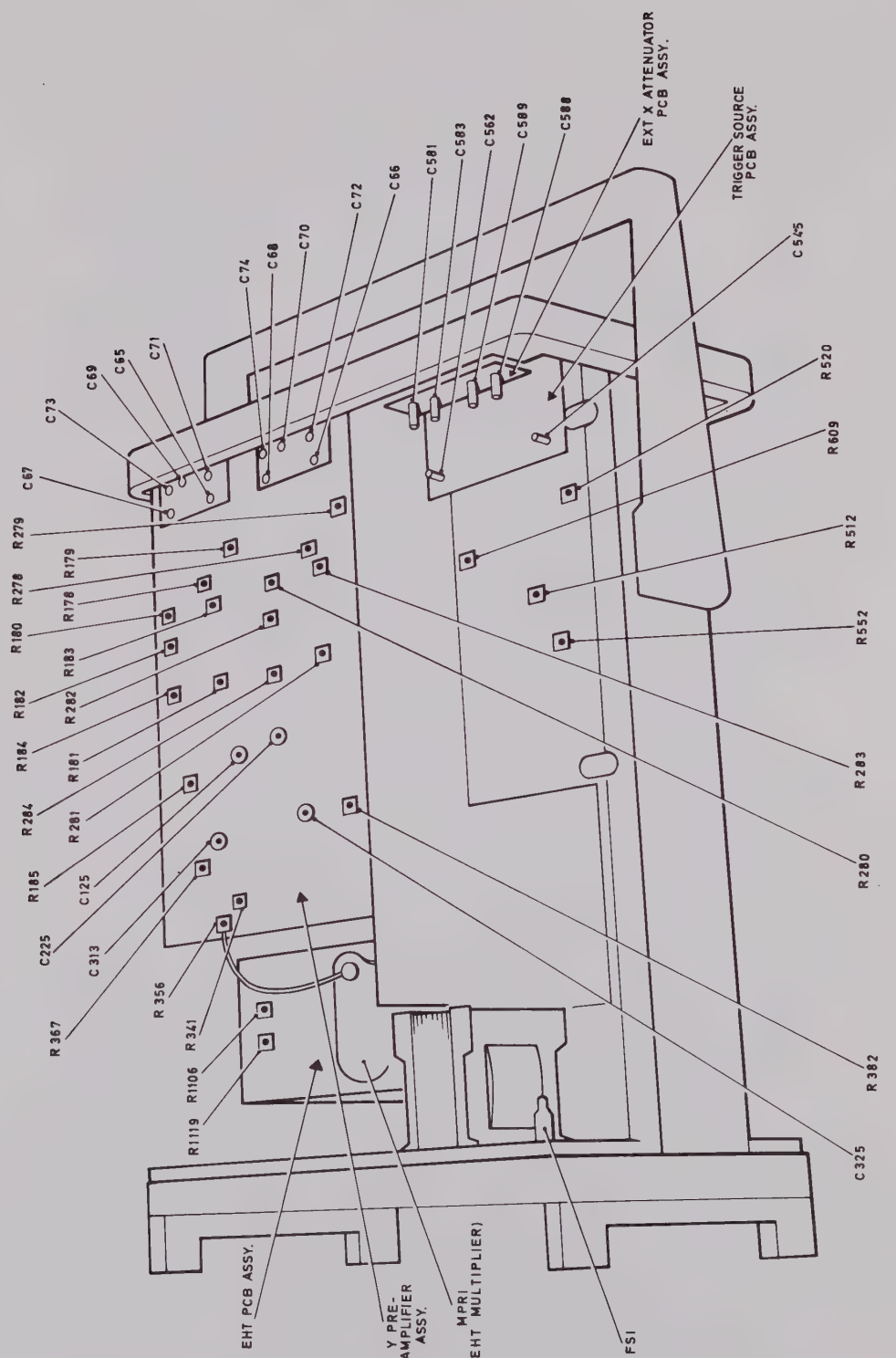
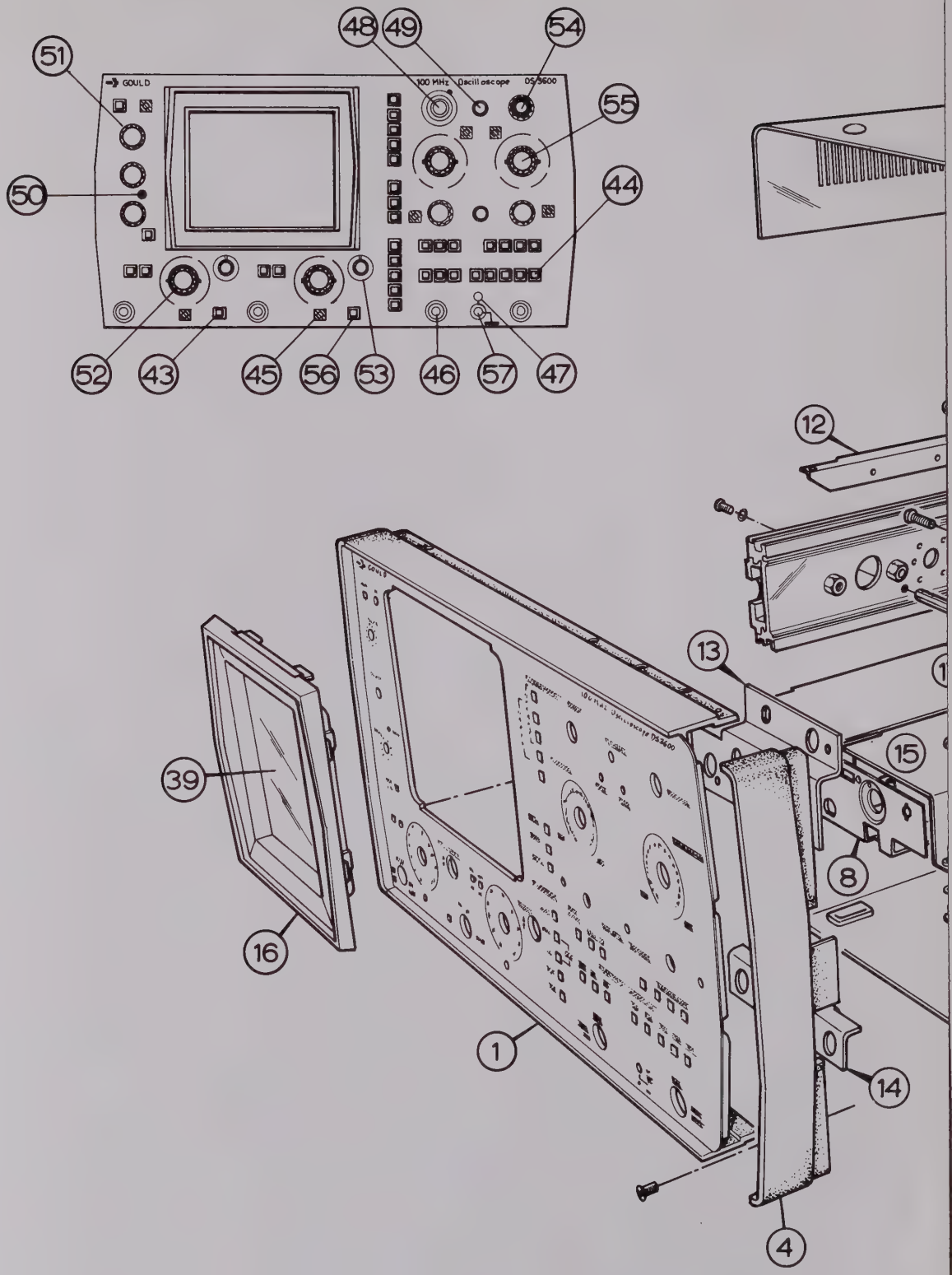


Fig. 14 Component Location Bottom View

Item No.	Pt. No.	Description	Qty.
1	42282	Panel Front Composite	1
2	40674	Panel Rear	1
3	42898	Side Support Bar	2
4	39096	Corner Frame	4
5	40809	Bracket Support E.H.T. C.R.T.	1
6	39101	Foot-Rear Support Moulding	2
7	43757	Handle Assy.	1
8	43208	Panel Attenuator	1
9	42382	Heatsink	1
10	42384	Mounting Bracket	1
11	40829	Bracket P.C.B. Support	1
12	42355	Bracket P.C.B. Support	1
13	40806	Bracket Pot. Mounting	1
14	43202	Bracket (Etx. X Atten. P.C.B.)	1
15	43209	Screen Attenuator	2
16	39100	Bezel	1
17	41822	Screen (Timebase/C.R.T.)	1
18	43074	Support Plate Front	1
19	43075	Support Plate Rear	1
20	39916	Trim Side Rear	2
21	39915	Trim Side Front	2
22	40844	Cover Rear	1
23	40813	Cover Bottom	1
24	40812	Cover Top	1
25	41002	Screen (Trigger)	1
26	40808	Screen E.H.T.	1
27	42876	Transformer Shield	1
28	40641	Foot Bottom Cover	4
29	37864	Latch	8
30	37915	'0' Ring	8
31	39097	Block Indexing	2
32	40677	Spacer to Bracket Assy.	2
33	40676	Spacer to Bracket Assy.	2
34	29206	Spring	2
35	32626	Circlip	2
36	40726	M3 Spacer	4
37	38006	Fuse Holder	1
38	33685 34790	Fuse Pt. No. 33685 500mA Pt. No. 34790 1A	2
39	40814	Filter Blue (Pt. No. 41381 Filter Amber)	1
40	41764	M4 x 10 Hex. Hd. St. Cad. Plate	2
41			
42			
43	40836	Knob P/B Light Brown	11
44	38407	Knob P/B Dark Brown	25
45	39884	L.E.D.	7
46	1222	B.N.C. Socket	6
47	31229	Insert Feed Through	1
48	36851	Dial Counting Knob	1
49	40408	Knob R2-234	4
50	49635	M4 Ø Bush	2
51	40923	Knob R2-354	5
52	40410	Knob (Wing) R4-454	4
53	41812	Nut Cover D/P W7-219	2
54	40925	Knob R2-124	1
55	40922	Knob R2-324	4
56	43256	Bezel - Pushbutton	36
57	40833	Terminal 4mm Earth	1

For serial Nos. from 5000 the following items have new part Nos.

1	44421	Panel Front Composite
2	44416	Panel Rear
3	44453	Side Support Bar
4	44412	Corner Frame
5	44529	Bracket Support E.H.T. C.R.T.
6	44413	Foot Rear Support Moulding
16	44405	Bezel
23	44943	Cover Bottom
24	44941	Cover Top
28	44528	Foot Bottom Cover
29	Deleted	
30	Deleted	
39	44481	Filter Blue (Pt. No. 44482 Filter Amber)


GOULD
100 MHz Oscilloscope
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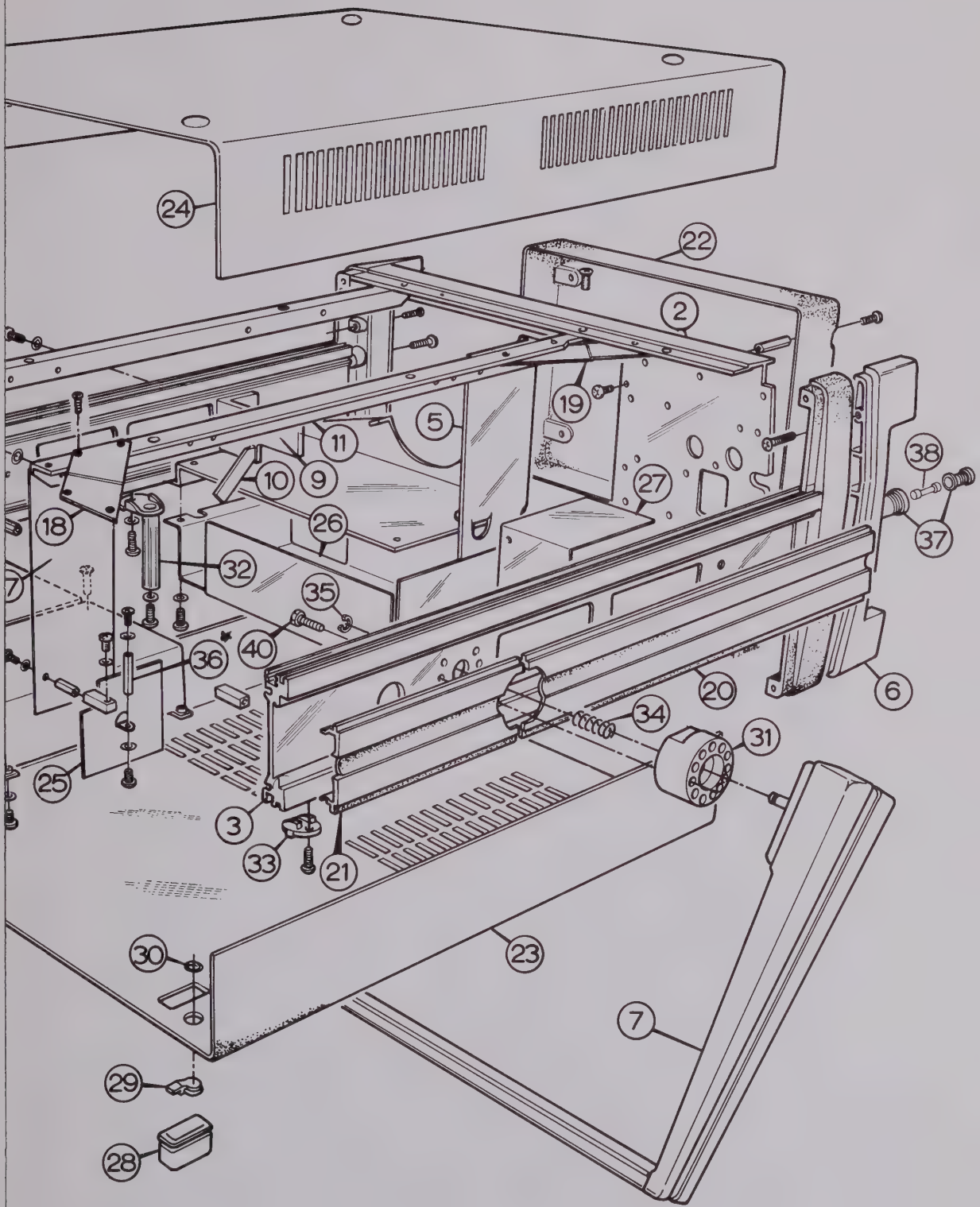

Fig. 15 Mechanical Assembly

Guarantee and Service Facilities

Section 7

This instrument is guaranteed for a period of two years from its delivery to the purchaser, covering faulty workmanship and replacement of defective parts other than cathode ray tubes and batteries (where fitted). Cathode ray tubes are subject to the manufacturers guarantee. This assumes fair wear and tear and usage in the specified environment and does not cover routine recalibrations and mechanical adjustments.

We maintain comprehensive after sales facilities and the instrument should be returned to our factory for servicing if this is necessary. The type and serial number of the instrument should always be quoted, together with full details of any fault and service required.

Equipment returned for servicing must be adequately packed, preferably in the box in which the instrument was supplied and shipped with transportation charges prepaid. We accept no responsibility for instruments arriving damaged. Should the cause of failure during the guarantee period be due to misuse or abuse of the instrument, or if the guarantee has expired the repair will be put in hand without delay and charged unless other instructions are received.

Our Sales, Service and Engineering Departments are ready to assist you at all times.

The Service Department can provide maintenance and repair information by telephone or letter, if required.

Note: Please check fuses before returning instruments for service and ensure that any 13 Amp mains plugs fitted are removed. To prevent possible transit damage, we regret that mains plugs cannot be returned.

Service Dept.,
Roebuck Road,
Hainault,
Essex,
IG6 3UE

Tel: 01-500 1000
Telex: 263785
Telegrams: Attenuate Ilford

WL 205 2 82

Manual Part Number 450038